PERCEPTIONS OF TEACHING CULTURALLY RELEVANT MATH LESSONS IN A

SIMULATED VIRTUAL CLASSROOM: A CASE STUDY OF PRESERVICE TEACHERS

A Dissertation

by

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Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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May 2020

Major Subject: Curriculum and Instruction

ABSTRACT

The Knowledge for Algebra Teaching for Equity (KATE) research team endeavored to redesign a mathematics problem solving course to provide opportunities for preservice teachers (PSTs) to practice creating and implementing culturally relevant lessons for middle school learners. The research team designed a virtual simulated classroom environment in Second Life (SL) for PSTs to practice teaching. The purpose of the current study was to capture and document PSTs' approaches in teaching culturally relevant lessons for the first time. The investigator also sought to learn about their lived experiences teaching the lessons in a simulated virtual classroom.

The design of the present study was a multiple and instrumental qualitative case study. Eight preservice teachers participated in the study. The project team interviewed the participants using a semi-structured interview protocol. Archival interview transcript data were used for this study. Employing a framework of culturally relevant pedagogy, the researcher analyzed the interviews verbatim from eight middle-grade mathematics preservice teachers. Both within-case and cross-case analysis were performed.

Findings from the current study revealed the necessity for providing more opportunities for preservice mathematics teachers to design culturally relevant lessons. Six themes emerged from the cross-case analyses of participants' experiences and approaches. Preservice teachers: 1) were not confident in their ability to plan culturally relevant lessons, 2) recognized the need to consider student perspective, and make problems relatable to real life, 3) mimicked instructor/class lesson examples, 4) wanted more practice teaching time (and earlier), 5) found SL teaching practices valuable but had some technical limitations, and 6) considered student engagement. The findings from this case study cannot be generalized to other preservice teachers but can perhaps provide several insights for the KATE research

team, or others engaged in similar work. It is the researcher's hope that the findings from this study help to make the case for the integration of CRP and practice-based teaching experiences early and often in mathematics teacher preparation coursework.

DEDICATION

This dissertation is dedicated to my family for traveling this journey with me, for loving me, believing in me, and for your endless support for my dreams. I love each of you to eternity and more than words can express. I appreciate your encouragement and pray for God's continued blessings in our lives.

To my parents, who motivated me to be the first girl in my extended family to graduate from high school, college, and higher at an early age, your dreams were not lost on me. Your love and value of education have inspired me to always reach for those dreams to come true.

To my friends…you have all being a blessing at different times in my life. I appreciate you and your prayers and not only when times were impossible.

ACKNOWLEDGEMENTS

To Dr. Trina Davis, completing this degree has been filled with many obstacles, but you have supported me in more ways than I can mention. You first put the right people together to facilitate my learning and sometimes you extended your role to motivator, English teacher, as well as an advisor for my professional growth. You opened doors so that I could experience this emerging virtual technology called Second Life. I shared your vision to use technology to develop educators who are willing to improve and change even when I was unknowledgeable about some things. Your support has been beyond measure and I appreciate your dedication, guidance, and wisdom that had made this academic journey achievable. So, even with the frustrations I am grateful that I will be able to share with the world your work and knowledge through me. Thank You.

Dr. Patricia Larke, your vision has always inspired me and has led to accomplish this work. I did not know the importance of multicultural issue until my first class with you. You set standards that challenged me but you offered support along the way. Thank you for focusing my vision to see the value and potential that lies ahead in this area of education. I have always wanted to thank you for showing so much care to learning, valuing your students as individuals which I happen to one of many. I am grateful that you have been here to guide and support my journey to be able to pass through this gate. Thank You.

Dr. Webb-Hasan, I sincerely appreciate your willingness to share your knowledge of research, read my drafts, and confirm my misconceptions. Thank you for your time spent reviewing my document and providing encouraging insights and directions. Your participation during this process has been invaluable and has deepened my understanding of my own misconceptions to find concise information. You helped me to research and also grow in this area.

To Dr. Yalvac, it was a privilege being a student in two of your courses. Your course was the first I took when I began this journey, and you reminded me of the best that comes out of logic and compromise. I am appreciative and grateful that you gave your time for me to experience this academic accomplishment. I am thankful to you for your expertise in methodology and encouragement to finish this research.

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INTRODUCTION

Perhaps the most dramatic changes in public schools in the past decade are the increased rates of student enrollment. The National Center for Education Statistics (NCES) estimated that total enrollment for 2019 (50.8 million) is at a record high. Between 2010 and 2020, enrollment in public schools increased three percent, and this new record is projected to increase every year until 2028 (51.4 million). The enrollment trend predicts that in the next few decades, a large proportion of students of color will underachieve in mathematics compared to their White middle-class peers in all measures of achievement (NCES, 2019). Although public school student enrollment was three percent higher in 2019, the rate of enrollment for teachers was one percent lower. Nearly 3.7 million full time public-school teachers were engaged in classroom instruction in 2019. NCES (2019) reported that African American students comprise about 15 percent of students in public schools, but African American teachers represent roughly seven percent of the teaching workforce.

This trend requires that teachers are poised to effectively engage and teach diverse students from various backgrounds. Based on this, there is a need for a more diverse teaching force that represents the changing demographics of student populations. However, most teachers are White, female, and middle class, and they do not have experience working with students from diverse cultures and backgrounds. Every teacher, regardless of race, ethnicity, class or gender, must be better prepared to teach all students by gaining the tools of cultural competence.

This approach to teaching diverse students is called culturally relevant pedagogy (Ladson-Billings,1994, 1995a, 1995c) also referred to as culturally responsive teaching (Gay, 2010, 2002). Gay (2009) states: "Preparing math teachers to be culturally

responsive to ethnically diverse students include acquiring new knowledge, attitudes, beliefs, and skills about self, students, subject matter, teaching, and learning" (p. 189). In mathematics, underserved students from marginalized populations struggle to perform and succeed. In 1997, Ladson-Billings recommended mathematics learning that emphasizes active problem-solving strategies rather than drill and passive approaches. She further explained the underperformance of culturally diverse students, especially African American students in mathematics, as the separation of the mathematics curriculum from the students' daily experiences. Teachers need to understand that mathematics is not culture free but context dependent. The National Assessment of Educational Progress (NAEP, 2008) states that mathematical achievement or an opportunity gap is an indication that not every student is receiving the same level of quality education.

Teachers' perceptions make it difficult to see the connection between mathematics and culture. Teachers' cultural beliefs and expectations have implications that affect classroom dynamics and influence how teachers teach (Ball, 1990a). Gay (2010) noted that most non-diverse teachers lack the cultural knowledge to make mathematics learning relevant to underserved students, and "[o]ne cannot start to solve a problem until it is identified and understood" (p. 70). Preparing culturally responsive teachers includes (1) transforming preservice teachers' attitudes (Villegas & Lucas, 2002; Reiter & Davis, 2011), (2) increasing their cultural knowledge (Gay, 2010), and (3) equipping them with the problem-solving skills to effectively teach culturally diverse students (McDiarmid & Price, 1990). If teachers do not know their own cultural blunders and obstruct the educational opportunities that they provide for students, they cannot uncover strategies for changing them. Ladson-Billings' (1994) work suggests that teachers' perceptions of their abilities to execute instructional strategies affect how they implement culturally relevant teaching practices in the classroom. Reiter and Davis (2011)

argue that the traditional teacher preparation programs have failed to bring about changes because teachers rarely had the opportunities to examine how their perceptions and attitudes contribute to their teaching and student behaviors.

Research has advocated for preparing culturally responsive teachers to teach in diverse classrooms (Ladson-Billings, 2001, 1999; Gay, 2010; Villegas & Lucas, 2002). Additionally, some researchers (Reiter & Davis, 2011; Siwatu et al., 2009) argue that teacher preparation should tend to new teachers' perceptions of mathematics, students, self-identities, teaching, and other expectations that predict future classroom behavior. According to (Gay, 2010; Nelson & Guerra, 2013), preservice teachers' beliefs predict whether they will implement culturally responsive teaching practices once they enter the classroom.

The demand for new teachers has significantly increased due to increases in student enrollment. According to Darling-Hammond (1995), finding qualified teachers in urban schools is a challenge. Children from underserved communities and students of color are most likely to be taught by inexperienced and underprepared teachers (Gay, 2010; Nelson & Guerra, 2013). Although a great deal of literature focuses on preparing (Caucasian) teachers to teach culturally diverse students (Kulm et al., 2011), the student-teacher cultural mismatch has made it difficult for teachers to connect with their students and provide adequate instructions. The teaching workforce has grown more diverse since "the dreamkeepers." In addition, teachers of color have been shown to positively influence the achievement of both minority and non-minority students. However, the growth has been overtaken by high rates of turnover.

Another problem is the gap between coursework and teaching practices that limit teacher experiences. The traditional structures of teacher education perpetuate the gap between coursework and teaching practice because many teacher preparation programs are developed in

isolation. Courses that address cultural knowledge are separate from those that present mathematics content and often taught by instructors in separate departments or programs (Kulm et al., 2011). These separate settings assume that the university instructor is responsible for teaching coursework (theory), while the teaching practice is left to in-service classroom teachers who have little communication with the instructor to provide preservice teachers with "real" interactive classroom experiences (Grossman at al., 2009).

Darling-Hammond (2006); Brown et al., (2011); and Kulm, et al., (2016) have argued that preservice teacher training should include teaching-practice experiences that demonstrate actual teaching practices in culturally diverse settings. However, many teaching-placement settings do not offer the opportunity to engage preservice teachers in culturally relevant practices. As the efforts to prepare teachers increase, there is also a need to ensure that teacher candidates implement equity instructional practices in the classroom. The definition of equity in the context of mathematics education is informed by the work of Ladson-Billings (1994) and the National Council of Teachers of Mathematics (NCTM; 2000). Teachers need to enact effective, equity-focused teaching practices that support underserved students in their learning. Fortunately, a few researchers are exploring how 3D virtual environments solve this issue. Broadley (2007) argued that preservice teachers cannot improve their instructional approaches and experiences in front of students in their initial stages of teaching. Preservice teachers need a necessary condition where learning, knowledge, and skills are acquired in the same setting. Classroom-simulation based virtual teaching environments enhance preservice teachers' abilities, responsibilities, skills and experiences in teaching.

Mathematics Achievement and Opportunity

From 2009 through 2019, the average mathematics scores for White students in 8th grade were higher than those of their African American and Latino American peers (NCES, 2019). Data from the assessment scores in mathematics revealed that White students on average scored higher than students of color. Darling-Hammond (2010) explained that much attention is given to the achievement gap and less to the opportunity gap. However, the opportunity gap presents an intolerable problem of social injustice, which she defines as:

> the accumulated differences in access to key educational resources–expert teachers, personalized attention, high quality curriculum opportunities, good educational materials, and plentiful information resources–that support learning at home and at school. (p. 30)

Teacher preparation is mostly responsible for the mathematics education of children and serves as the starting point for developing highly qualified teachers (Kulm et al., 2011) with the knowledge of culturally relevant teaching and underserved students (Brown, 2011) and situated pedagogy (Davis et al., 2011). To Darling-Hammond (2010), the continuous low-level achievement of students from diverse backgrounds is a function of unequal access to key educational resources as well as how students are perceived regarding their race, class, or culture.

Gay (2010) suggests that underserved students have similar opportunities, such as one would not predict their mathematical outcomes based on their race/ethnicity and socioeconomic background. Further, Gay explained that the consequences of disproportionally high levels of low achievement are: "long term and wide-reaching, personal and civic, individual and collective" (Gay, 2010, p.1). Brown, et al., (2011) argues that the opportunity gap in

mathematics learning between White students and students of color poses a major problem to individual learners as well as society. The mathematical achievement gap that exists between the races indicates that not everyone receives the same opportunities for a quality education (NAEP, 2008).

Background of the Study

This study extends ongoing research on the efforts to prepare preservice mathematics teachers to design culturally relevant lessons. The Knowledge for Algebra Teaching for Equity (KATE) project team endeavored to redesign a problem-solving course for preservice teachers. Funded by NSF, educators and researchers at Texas A&M University employed culturally relevant instructional approaches in a required problem-solving course with a focus on teaching algebra for equity. The KATE Project engaged preservice teachers in practice-based teaching experiences with culturally diverse student avatars in a virtual classroom in Second Life.

Statement of Problems

Research is lacking in preparing high quality teachers to teach algebra for equity. However, algebra is considered a "filter" that prevents many students from learning higher-level mathematics courses in high school, which limits their preparation for college and their selection of (STEM) careers (Brown, et al., 2011). In 1990, Bob Moses argued that learning algebra increases educational and economic opportunities for underserved students because Algebra plays a crucial role in providing access to higher level mathematics learning.

In 2000, the National Council of Teachers of Mathematics' Principles and standards for school mathematics provided six principles: equity, curriculum, teaching, learning, assessment, and technology. The integration of all six principles is necessary for creating an effective learning environment. The equity principle requires: (1) high expectations and opportunities, (2)

accommodating differences to help students learn mathematics, and (3) employing resources to support all students in the classroom. However, these requirements fail to recognize issues of situated teaching and learning in which culture is embedded in mathematics learning. Equity means that all students have opportunity to learn high-level mathematics.

In the pursuit of equity in mathematics teaching, culturally relevant content teaching is identified as one of the most important methods of effectively engaging students in mathematics learning. The student-teacher cultural mismatch makes it difficult for teachers to connect mathematics, students, and instruction. The National Mathematics Advisory Panel, [NMAP], (2008) excludes non-technical issues, such as teacher identity and cultural knowledge that are important for students' experiences in Although there is focus on improving the quality of mathematics teaching in schools by improving teacher preparation, preparing culturally responsive teachers to teach cultural content in today's diverse classrooms is the most daunting task (Gay, 2010). A typical teacher candidate in a middle-grade mathematics classroom is a middle-class White female (Kulm et al, 2011; Ladson-Billings, 1997). The call for the re-examination and redesign of teacher education has spanned decades (Darling-Hammond, 1995). Therefore, educational reform needs to begin by changing teachers' perceptions and expectations about cultural diversity and students with classroom instruction.

Effective teaching is the single most important indicator of students' academic success and achievement (Ladson-Billings,1994), and teaching for equity is one of the most common ways to avoid a narrow curriculum (Gay, 2010). Teaching for equity is continually constructed and evolving; thus, preparing preservice teachers for effective teaching for equity in public schools is crucial to develop all students' experiences (Ladson-Billings, 2001; Gay, 2010) regardless of their backgrounds. However, curriculum-related instructional approaches have

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focused on textbook-based, teacher-centered instruction instead of a multidimensional knowledge delivery, problem-solving, critical thinking, and multimedia material presentations.

Culturally Relevant Pedagogy and Responsive Teaching

For years, culturally relevant instruction served as a solution to meet the needs of students. This dissertation draws upon Gloria Ladson-Billings' framework of culturally relevant pedagogy (CRP) by introducing the students' backgrounds, experiences and prior knowledge in the classroom and curriculum (Ladson-Billings, 1994). In mathematics, the importance of culturally relevant teaching is least studied and analyzed. Teachers must develop socio-cultural consciousness and a holistic view of underserved students before they engage in CRT. Ladson-Billings (1994) defined the framework of culturally relevant pedagogy as an approach to teaching and learning that, "empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes" (pp. 17-18).

Culturally relevant and responsive teachings are separate but overlapping terms that are used interchangeably to call for changes in teaching approaches and curriculum transformations. For clarity, Ladson-Billings (1994) uses the term "culturally relevant pedagogy" to refer to practical teaching approaches that are relevant for diverse classroom learning and beyond. In her 1994 landmark book titled "The Dreamkeepers," Ladson-Billings highlights the inequity of the education of African American students and teaching practices.

Gay (2009, 2010) asserts that culturally responsive teaching is grounded in culturally relevant pedagogy knowledge that supports the learning of all students. These terms "culturally relevant pedagogy," "culturally responsive teaching," or "culturally relevant teaching," (Ladson-Billings, 1995c; Gay, 2010) are used interchangeably. So, there is consensus that culturally

relevant pedagogy encourages the use of students' cultural knowledge and experiences as tools to facilitate classroom teaching and learning (Ladson-Billings, 1995b).

In this study, the term "culturally relevant pedagogy" is used consistently because preservice teachers perceive it as a practical approach to transform classroom teaching. Also, Gay's alternative term of "culturally responsive teaching" is used to describe teaching practices that recognize diverse students' backgrounds and varying levels of knowledge in the classroom. Most importantly, Ladson-Billings' (1994, 2009) and Gay's (2009, 2010) argue that conventional teaching approaches are inadequate for educators to improve the academic achievement of students from diverse populations. Both share their research findings to advance culturally based curriculum content and instructional practices for teachers who work with underserved students. Further, Gloria Ladson-Billings (1994, 2009) approaches her work of culturally relevant pedagogy (CRP) from the position of a critical race theorist. Critical race theory includes challenging the conventional notions of teaching and the practices of educational inequality. Her research demonstrates the importance of using CRP to offer suggestions for educators to improve the teaching and learning of students' who are underserved, underrepresented, discriminated against, and unjustly harmed by the educational system.

Building on Ladson-Billings' conceptual framework, Geneva Gay advances her research in culturally Responsive Teaching (CRT) from her perspective as a multiculturalist. Geneva Gay (2000) defines culturally responsive teaching as:

> using the cultural knowledge, prior experiences, and performance styles of diverse students to make learning more appropriate and effective for them; it teaches to and through the strengths of these students (p. 29).

Gay explores CRT to contest issues of inequity and make suggests for instructional changes. Both researchers have developed teaching and learning practices that highlight the connection between mathematics and the culture of students to combat their low academic achievements.

Gay's assessment of CRT is based on the ways that African, Asian, Latino, and Native American students are educated. Teachers who are not prepared to understand the knowledge of culturally responsive teaching are at a major disadvantage in today's classroom in public schools with respect to the quality and level of learning they provide to the increasingly diverse student populations (Gay, 2009). Culturally responsive teaching is a "means for unleashing the higher learning potentials of ethnically diverse students by simultaneously cultivating their academic and psychosocial abilities" (Gay, 2010, p. 21). At a time of rapid demographic changes and amidst many educational challenges, it is critical to present mathematics education from a culturally responsive perspective (Gay, 2009). Thus, learning to teach mathematics lessons requires culturally diverse content in the curriculum and responding to ethnic diversity in the delivery of instructions (Gay, 2009).

In her book, Culturally Responsive Teaching: Theory, Research, & Practice (2nd edition), Gay (2010) argues that:

> developing a knowledge base about cultural diversity, including ethnic and culturally diverse content in the curriculum, demonstrating caring, building learning communities, and responding to ethnic diversity in the delivery of instruction, are essential elements of culturally responsive teaching. (p. 106)

Gay (2010) maintains that many preservice teachers lack the knowledge to work in diverse classrooms and provide equal learning opportunities to varying cultures of students (Gay, 2010). She asserts that CRT:

…is anchored on four foundational pillars of practice – teacher attitudes and

expectations, cultural communication in the classroom, culturally diverse content in the

curriculum, and culturally congruent instructional strategies. (p. 46)

Therefore, for teachers to be effective with underserved students, they must possess knowledge

about cultural diversity that validates, liberates, and empowers students. Teachers must

understand the ways in which students work within their own "cultural frames of reference"

(Gay, 2010. P. 26).

Most teacher candidates report feeling frustrated and isolated; therefore, they engage in

"survival only" modes (Darling-Hammond, 2006). The traditional student teaching model does

not adequately prepare teachers for proper entry into most classrooms. Most teachers view

practice-based teaching experiences and student teaching as the most valuable aspects of their

training because most of their knowledge comes from firsthand experience (Darling-Hammond,

2006). The Council of Chief State School Officers' [CCSSO], (2011) report raised concerns over

the effects of student learning by transforming teacher preparation, concluding that the quality of

preparation often determines the success a teacher has in the classroom. Teaching practices are

offered for insufficient durations in inappropriate teaching sites (Ladson-Billings, 2001) and with

insufficient support of preservice teachers (NCATE, 2010). NCATE (2010) concluded that

teaching practices that are "poorly defined and inadequately supported" (p. 4).

Ladson-Billings' (1995) review of literature on teacher preparation for diverse

classrooms indicates that most teaching approaches are satisfied with adding isolated

"multicultural content" courses and conducting teaching practice experiences in non-diverse

settings to satisfy the standards for teaching. Although no single coursework or teaching practice

is adequate in preparing preservice teachers for the needs of diverse learners, isolated teaching

seems too traditional and irrelevant to what culturally relevant teachers do in classrooms with actual students. Thus, traditional programs have made little headway in shifting preservice teachers' perceptions of their knowledge of culture and mathematics to enhance cultural relevance. Furthermore, Brown et al., (2011) posit that, besides cultural knowledge in coursework, preservice teachers must experience what it is like to teach mathematics to culturally diverse students. Their experiential practices are necessary for them to understand the cultural knowledge and problem-solving misconceptions of underserved students.

Other scholars have argued for the need to provide culturally sensitive learning contexts (Ladson-Billings, 2001; Larke, 1990). The traditional model of teacher preparation assumes that preservice teachers acquire cultural knowledge from coursework in one context (the university) and teaching experiences in another context (the school sites). Thus, preservice teachers are placed in separate, in-service classrooms that are often located on different school sites (urban or suburban schools) where the university instructor has limited communication with the classroom teacher. Furthermore, the teaching practices that engage students in mathematics may be different from what preservice teachers have acquired in their coursework with the university instructor. Besides, student learning cannot be sacrificed for preservice teachers' teaching experiences, and they navigate within these two contexts on their own. Therefore, both contexts have little awareness of the ideas that either one is promoting. Consequently, the opportunities for continued support for preservice teachers to integrate their coursework knowledge into their teaching practice experiences are limited to that of a passive receiver of information. A review of studies on students' teaching suggests that little is known about how this teaching enables or constrains PSTs' learning. The teaching practice remains unclear on what PSTs learn from student teaching (Anderson & Stillman, 2013).

Conceptual Framework

This study is grounded in two frameworks: social constructivism (Creswell, 2012) and culturally relevant pedagogy (Ladson-Billings, 1994, Gay, 2000). Elements of these models are complementary to the perspective of the cultural context of situated learning and are considered critical for teaching diverse learners.

Social Constructivism

The framework of social constructivism rests on the assumption that learning is socially constructed through interactions with the environment (Merriam, 2009). Social constructivism acknowledges what students and teachers bring into the learning environment, including misconceptions, false beliefs, and interpretations. Creswell (2007) states:

> The social constructivism paradigm allows individuals to seek understanding of the world in which they live and work…Develop subjective meanings of their experiences. These meanings are varied and multiple…Formed through interaction with others (hence social constructivism) and through historical and cultural norms that operate in the individual's lives. (pp. 20-21)

Social constructivists argue that people form their own knowledge based on their individual experiences and social interactions. Multiple realities exist when knowledge is socially constructed, and values and biases are revealed (Creswell, 2007). So, in terms of instructional practice, both teaching and learning is constructed in a social environment and the actions of both teacher and student attribute meaning to their beliefs.

Additionally, from a social constructivist perspective, knowledge is constantly changing through struggle, dialogue, and transformation. Therefore, the "processes" of interaction among individuals must focus on the specific contexts in which people live and work to understand their

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cultural settings (Creswell, 2007). Thus, the social constructivist process of learning follows that knowledge is acquired and understood through multiple voices and realities. Within this framework, interrelated factors include reversing the conventional pattern of direct instructions and repetitions. The teaching and learning of mathematics must be viewed as a "process of active individual construction and a process of enculturation into the mathematical practices of a wider society" (Cobb, 1994, p. 13). Following the concepts of social constructivist theory is the conceptual framework of Culturally Relevant Pedagogy by Ladson-Billings (1994). While social constructivism theory is substantial in opening the door to connect the learner and subject matter, culturally relevant pedagogy provides the practical framework for understanding effective teacher approaches and interactions with students.

Culturally Relevant Pedagogy (CRP)

This framework consists of work done by Ladson-Billings (1994,1995a, 1995b, 1995c, 2009) that includes research on Effective Mathematics Instructions of African American students. Ladson-Billings' (1995a) framework of culturally relevant pedagogy serves as the guiding perspective of this study and is based on three elements: 1) Students must "experience academic success"; 2) Students must "develop and/or maintain cultural competence"; and 3) students must "develop a critical consciousness through which they challenge the status quo of the current social order" (Ladson-Billings, 1995a, p. 160). Archival data maintains that Ladson-Billings' phrases "culturally relevant pedagogy" as an overarching conceptual framework that prepares preservice teachers to make sense of their own experiences in coursework and teaching practice. Historically, the interest in culturally relevant pedagogy stems from a growing body of evidence showing that underserved students are consistently underperforming on standardized tests compared to non-minority students (Ladson-Billings, 1995c). Thus, culturally relevant

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pedagogy evolved out of the need to "make classroom instruction more consistent with the cultural orientations of ethnically diverse students" (Gay, 2010, p. 29). Further, Ladson-Billings (1995) maintains that effective instruction draws upon students' cultures and community-based knowledge because mathematics is not "culture free". Gay (2000) terms the idea along with:

> academic achievement, social consciousness and critique, cultural affirmation, competence, and exchange; community building and personal connections; individual self-worth and abilities; and an ethic of caring. (p. 43)

Thus, culturally relevant pedagogy proposed by Ladson-Billings' (1994) is a framework for teaching that (1) uses students' cultural experiences (familiar situations, examples, and pictures) as a 'conduit' to facilitate the teaching and learning process (curriculum and instruction), (2) incorporates cultural contexts to design culturally friendly classroom environments, (3) provides multiple opportunities to enable students to actively construct learning using a variety of teaching techniques, and (4) provides underserved students with the knowledge and skills to function in both mainstream and maintain their own culture. Ladson-Billings (1995) stated that,

> all students can be successful in mathematics when their understanding of it is linked to meaningful cultural referents, and when the instruction assumes that all students are capable of mastering the subject matter. (p. 141)

Ladson-Billings (1995c) explains that "pedagogy" applies to teachers and their classroom practice and the elements of CRP have yielded better performance outcomes for underserved students. The purpose for choosing this framework is to extend the discussion about CRP to connect students' everyday lives and community settings that provide research examples of

successful teaching practices that have contributed to teachers' knowledge of teaching underserved students.

The Power of Virtual World (VW) Technologies

The power of virtual world technology makes it easier to fit in the approaches of culturally relevant pedagogy in coursework and practice-based teaching experiences through simulations, role-play, two-way communications, and connections to expert instructors. Virtual worlds are "an electronic environment that visually mimics complex physical spaces, where people can interact with each other and with virtual objects, and where people are represented by animated characters" (Bainbridge, 2007, p. 472). According to Mirliss, May, and Zedeck (2012), a unique aspect of virtual worlds is the representation of oneself as an avatar. Avatars are customizable personal characters that students and teachers construct to facilitate role-play experiences, engagements, and interactions in simulations. With Avatars, preservice teachers assume alternative digital identities (as avatars) that are drastically different from their real-world identities in terms of age, race, ethnicity, and physical appearance to enhance their transformation, engagement, interactions, and experience simulating real-life classroom activities (Mirliss, et al., 2012). Lee and Hoadley (2006) add that in adopting an alternate identity, preservice teachers are challenged to think and view problems outside of their comfort zone. The behaviors of the teachers performing their teaching practice through avatars can disinhibit them to become more active, relaxed or confident which is difficult to do in real-world classroom settings (Cheong, 2010).

Although specific VWs models are limited in preparing preservice teachers to teach mathematics lessons, there are practice strategies that have been proven useful for: (1) supporting, collaborating, and connecting; (2) situating learning, "hands-on" experience, and

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feedback; (3) active interaction, and role-playing; and (4) multiple representations of curricula. Thus, the introduction of VWs in a teacher preparation program provides an opportunity for preservice teachers to engage in culturally relevant mathematics teaching.

Second life. Most relevant to this study is that research and development teams can use virtual worlds to design authentic simulations of classrooms for preservice teachers to practice teaching in a controlled setting (Brown, et al., 2011). Powerful three-dimensional (3D) VWs environments such as Second Life offer an alternative to real-life scenarios that foster experiential and situated learning approaches (Davis, 2012, 2013). Second Life has been in the lead of new technological and experiential learning to communicate and present problem-solving. Second Life is recognized in higher education as the most active VWs (Blake & Moseley, 2010). The Second Life platform environment is full of visualization, imagination, and innovation where multi-users through avatars help to address the constraints of teacher preparation by contributing to the restructuring of both coursework and teaching practice experiences. Particularly, SL "provide(s) access to authentic simulations of . . . situations that would be otherwise impossible to experience" (Cunningham & Harrison, 2010, p. 98). Through simulations of real-life contexts, objects, activities, behaviors, actions and events are supported. In Figure 1, the Second Life virtual classroom environment is available for simulation and as an alternative to a real classroom to support preservice teachers to development teaching practice.

Figure 1: PST in the KATE's Second Life Virtual Classroom with Students.

Educators have experimented with SL to supplement preservice teachers with situated learning experiences as part of their teaching practice. For example, Figure 1 shows how the KATEs' program provided PSTs access to learning opportunities that promoted knowledge sharing for both students and teachers. By exploring SL simulation for preservice teachers' practice experiences with diverse students, research has begun to train preservice teachers to hold virtual teaching practice sessions. This engages students in learning specific content in multiple representations, using animated objects, media images, videos, and web pages in real time (De Lucia et al., 2009). Even though the power of SL is reinventing teacher preparation, and evidence shows that interactions in the real world can also be carried out (or simulated) in SL, research in the preparation of mathematics PSTs is limited. But, through presentations, demonstrations, and communications, teachers can apply specific content knowledge in the classrooms using VWs such as SL as a practice-based teaching space.

Teacher Preparation Programs

A challenge in teacher preparation is that most traditional models of teacher preparation rely on pedagogy that is defined as "culture neutral" (Shulman, 1987). Many teachers report that their teacher preparation programs do little to prepare them for culturally diverse classrooms (Ladson-Billings, 1995b). Traditional teacher preparation programs are disconnected from the realities of today's classrooms (Kulm et al, 2011). NCATE Standard 4 focuses on diversity, stating, "The unit designs, implements, and evaluates curriculum and experiences for candidates to acquire and apply the knowledge, skills, and dispositions necessary to help all students learn" (NCATE, 2008, p. 34). Despite repeated calls from the National Council for Accreditation of Teacher Education (NCATE, 2008) to reduce the barriers of cultural differences in today's classrooms, teacher candidates are leaving their teacher preparation programs with limited skills and knowledge needed to work with underserved students.

Researchers and practitioners have identified teaching practices as an area that needs attention. Teaching practices are components of nearly all teacher preparation programs. The main concern of the NCATE (2010) is to improve the quality of teaching practices and enhance the lack of diversity in the teacher workforce. Reiter and Davis (2011) stated that even when teacher preparation programs include teaching practices that provide preservice teachers with practical experience in real classrooms, teachers are exposed to a small sample of diverse learners. University-based teacher preparation is gaining attention for connecting coursework to teacher candidates' experiences; however, their focus is limited because teaching practices have been ineffective in preparing new teachers (Campbell & Dunleavy, 2016).

The KATE Teacher Preparation: A Response to the Problem

The Knowledge for Algebra Teaching for Equity (KATE) was a project aimed to develop middle grade mathematics preservice teachers. Concerns about inconsistent program quality and the under-preparedness of new teachers led KATE researchers to design experiences that explored new models for teaching practices. Emerging research has focused on preservice teachers' problem-solving skills (Kulm, et al., 2016) and the restructuring of teacher preparation programs that include culturally responsive pedagogical approaches (Brown, et al., 2011). According to (Kulm et al., 2011), the effectiveness of teacher preparation programs lies in the efficiency of highly qualified teachers. The KATE Project took on the challenge of exploring the virtual technology-enriched environment to prepare middle-grade mathematics teachers in creating algebra lessons for their practice teaching experiences. Since the KATE candidates come from a relatively homogenous White population, many have not experienced interacting with students from diverse backgrounds. They learned to practice teaching algebra and to reflect on their approaches.

The KATE Project research team pushed pass traditional models to create a simulated classroom environment for PSTs to design and practice teaching culturally relevant problem-solving lessons. Prior to PSTs engaging in field experiences participating schools, the project leadership worked to prepare teachers by situating their "early" learning experiences in the context of practice within the university environment (Anderson, 2013). The PSTs' focus was on self-reflection that required them to understand their own perceptions, expectations, and interactions in a process that was used by successful teachers in Ladson-Billings' (1995) research.

Geneva Gay, who has written classic texts on culturally responsive education, added that African, Native, Latino, and students of low socioeconomic status do not have high achievement in mathematics compared to their counterparts from middle-class and White cultural backgrounds. Gay (2010) explains that, one of the reasons for low achievements in mathematics is that the majority of teachers do not share the same cultural, linguistic, or racial backgrounds as the majority of students. They do not understand the values and cultures of these students and often mistakenly attribute their struggles with a lack of ability, interest, or motivation. These perceptions are unfounded.

A mathematics curriculum must be conceived in real contexts that reflect the realities of diverse populations of students to provide learning opportunities for them. Gay (2010) argues that the inclusion of certain social and economic contexts in the mathematics curriculum may provide affirmation for students to explore mathematics ideas. She suggests that teaching practices embrace, affirm, and begin with broader curricula content to link with what students bring to the classroom. She explains that the key is to select broader curricula materials that are representative of many cultural group experiences that address mathematics and cultural interconnections of learner characteristics and methods of thinking and reasoning in their everyday lives. Ladson-Billings (1997) asserts, it is not enough to consider student achievement in isolation. Although underserved students in urban schools have access to mathematics content, it is disconnected from their cultural backgrounds, which then presents a barrier that makes it difficult for them to make connections or draw upon their cultural strengths to achieve success. Teachers should engage students in mathematical activities that are embedded in their social contexts (Ladson-Billing, 1995a). These problems can be addressed by improving the quality of

mathematical teachers and their experiences relevant to the experiences of impacting the lives of underserved students.

Gay (2010) argued that underserved students' low performances in mathematics result from disconnects that exist between their experiences at home and those in the classroom. The content of mathematics is divorced from students' everyday experiences, making mathematics irrelevant to them. Based in the Virtual Worlds technology setting in SL, PSTs worked closely with course instructors to critically examine the mathematics curriculum for teaching middle-grade diverse classrooms. The KATE Project has advocated for a broader curriculum to teach culturally diverse student populations. This curriculum requires modifying the algebra content to include a variety of culturally relevant materials of mathematics learning.

Gay (2010) states that it is important to provide a broader curriculum because a narrow curriculum provides limited learning opportunities to enable all learners with familiar examples to make connections. Preservice teachers need to be prepared to acquire specific mathematics content and cultural knowledge to plan meaningful lessons and select appropriate instructional strategies for students. Therefore, part of the algebra coursework was focused on PSTs' planning culturally relevant problem-solving lessons that connect to students' knowledge. The other part required PSTs to experience practicing teaching algebra lessons in a simulated environment in SL. Thus, preservice teachers need cultural knowledge and diverse community awareness to plan a mathematics curriculum that suits the learning styles of diverse students. This knowledge base is acquired through preservice teachers learning to create culturally relevant lessons in similar ways to ones they should use with underserved students in their own future classrooms. Literature about the preparation of new teachers has explored the inabilities of teachers to provide equal learning opportunities for underserved students to excel in mathematics (Gay,

2010; Darling-Hammond & Bransford, 2005). The current focus on PSTs' problem-solving skills is linked to the widely accepted notion that conventional mathematical teaching practices have had minimum effects on student achievement.

The KATE Project took up the challenge to examine specific issues that PSTs struggle with while building and improving their skills (Kulm et al., 2016). This process helps to create an intervention that supports PSTs in their algebra problem-solving course and to challenge the conventional instructional practices that are prevalent in public school classrooms. The KATE Project added equity to highlight the dimensions critical to teaching mathematics. The KATE team created Glasscock Island which contained a virtual middle-grade mathematics classroom in SL that simulates a real-life classroom (see Figure 1). KATE project efforts immersed PSTs in practice-teaching experiences in a virtual classroom setting. The simulated virtual classroom (SVC) was designed to offer an environment for authentic classroom scenarios to support mathematics learning and teacher development in emergent situations (Davis, 2012, 2013). The SVC is considered an intervention that is necessary for PSTs to experience practice teaching of algebra with diverse middle-grade students (aka avatar students). Unless PST experience culturally relevant teaching themselves, they will rarely consider the approaches in their classrooms or in the delivery of their classroom instruction (Kulm, et al., 2016). The process used a variety of tools for engagement, communication, role-play, and simulation to enable PSTs to experience real-life situations in teaching and learning. PSTs are introduced to comprehensive approaches for developing culturally relevant knowledge that address algebra problem-solving with diverse students. Thus, they participated in role-play learning without being in real classroom environments (Savin-Baden 2011) to address their own perceptions, instructional approaches, student misconceptions, and problem-solving skills in the middle-grades (Kulm et

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al., 2011). Assisting PSTs to advance in creating culturally relevant lessons helps in their

perceptions of cultural knowledge, as well as teaching and instructional strategies is unique and

aims at promoting experiential and situated learning without the unnecessary risks to students.

Some educators (Shulman, 1987) emphasize that teacher's need cultural knowledge, or

simply, they need to know their students. Teachers need to know students, their life experiences,

communities, and sociopolitical contexts (Ladson-Billings, 1994). So, to improve student

engagement and increase their access to learning opportunities, teacher educators need to

develop PSTs' cultural knowledge and problem-solving skills to incorporate community issues

into classroom instructions. However, building culturally relevant pedagogy is challenging

because a typical teacher candidate in a middle-grade mathematics classroom is a middle-class

White female (Kulm et al, 2011). The teaching workforce is culturally and socially homogenous

and the mathematics curriculum is intimately aligned with an "idealized cultural experience"

synonymous with middle-class Caucasians (Ladson-Billings, 1997). Limited research on the

significance of teachers' identities, perceptions, and attitudes is a major factor in students'

academic success (Reiter & Davis, 2011). When new teachers enter public school classrooms,

they experience clashes between what they expect, based on their preservice teacher preparations

(Ladson-Billings, 2000; Nelson & Guerra, 2013; Reiter & Davis, 2011; Gay, 2010, 2009, 2000).

These researchers have shown that when teachers do not examine their own attitudes and

perceptions, it presents problems because they do not share the same frames of reference with

students, and it interferes with their engagement of these students.

Current study. Drawing from the influential literature of Ladson-Billings (1994), this

study aims to highlight the ways that specific mathematics problem solving lesson plans support

PSTs' equity teaching practices. While there is a growing body of research that emphasizes

culturally relevant pedagogy, there is still limited qualitative research that involves mathematics

PSTs. Ortiz (2018) argues that there are individualistic distinctions that accompany what

McKenzie and Locke have termed as an asset. So, we must look beyond the raw data of

achievement to ponder what McKenzie and Locke (2009) established as rich diversity within the

schools. This asset is not constructed productively, if the curriculum does not reflect elements of

students' culture. Ortiz (2018) argued that the idea of "all" neglects diversity ideas of cultural

relevance. He contended that in attempt to account for "all", we erase any means of diversity and

dilute the potential of a mathematics curriculum that is culturally relevant. Ortiz reminds teachers

and teacher educators that cultural relevance, in its push towards establishing equity in

mathematics education, does not omit specifics about culture and difference, it utilizes it in the

instructional process. Ortiz asserted that this is an aspect of McKenzie and Locke's (2009)

perspectives that PSTs did not fully employ. This diversity should be embraced and viewed as an

asset and is one of the driving forces in this dissertation.

Purpose of the Study

The purpose of this study was to examine data that were collected from interviews

conducted by the KATE researchers. The study was designed to identify the key instructional

approaches of PSTs participating in the project. The study explores PSTs teaching practice in a

simulated virtual classroom. This helps to understand PSTs' cultural knowledge, problem-

solving skills, and teaching experiences in order to determine the components of their

instructional approaches. More specifically, this study examined how the MASC problem

solving course guided PSTs' culturally relevant teaching practice. Teaching and learning consist

of interactions between teachers and students for the purpose of constructing new knowledge

(Ladson-Billings, 1994; Kennedy, 1999). The KATE Project combines coursework and teaching

practice in an undergraduate mathematics methods course to afford eight PSTs the opportunity to practice situated learning rather than the conventional methods. This environment provides teacher candidates with the ability to pose and solve algebra problems and to socially interact with students.

The current study captures the voices and interpretations of PSTs' problem-solving and classroom teaching experiences within the context of a simulated classroom. This study contends that teachers need to understand their students' cultural backgrounds and their own identities when teaching underserved students (Ladson-Billings, 2000). To Ladson-Billings, the study of one's self and other's viewpoints in the context of life experiences might provide self-awareness. This study helps preservice teachers to examine their self-ability and expectations, attitudes, beliefs and their responsibility in teaching for equity. Preservice teachers need to reflect on their own actions because it is the teacher who makes instructional decisions to enhance the learning context. It is the teacher who explains new concepts and poses questions to challenge students' misconceptions. This study highlights preservice teachers' critical reflections of their own perceptions during a problem-solving course. If PSTs' perceptions of their experiences are left unchallenged, they will not change.

Research Questions

In applying the social constructivism theory and a culturally relevant pedagogical framework in this collective case study, the following research questions guide this study:

- What are preservice teachers' approaches in teaching culturally relevant lessons during a problem-solving course?

- What are preservice teachers' perceptions regarding their teaching experiences in a simulated classroom in Second Life (SL)?

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Significance of the Study

The effort of this study is to adopt Ladson-Billings' (1994) argument for applying

culturally relevant teaching that provides evidence-based instructional approaches to teaching

practices. Lee Shulman, a former professor at Stanford University, focused on the teacher's

knowledge of teaching and subject matter. Others (Nelson & Guerra, 2013) have argued that

teachers need a strong understanding of mathematics and cultural knowledge to engage diverse

students in their teaching. Yet others (NCTM, 2011; Brown, et al., 2011; Sleeter, 2001; Ladson-

Billings, 1994, 2000) assert that teachers must have a comprehensive understanding of

underserved students and their communities to make mathematics meaningful and transformative

to students. This study adds to recent development in trying to bridge the coursework and

teaching practice gap using virtual classroom simulations in SL. It combines lesson planning and

specific instructional approaches that are promoted in coursework with the realities of classroom

teaching practices. Therefore, the study also assists in clarifying the obstacles that hinder

preservice teachers from teaching for equity.

Further, the study contributes to the dialogue for teaching algebra to diverse middle-grade

algebra students equitably and helps to address the need to reexamine conventional mathematics

instructions in support of teaching and learning algebra. This PST in hands-on experiences, gives

them critical views of teaching and learning (Darling-Hammond, 2006). This study reports on

the cultural knowledge of middle-grade teacher candidates; their practice teaching experiences in

Second Life rather than the sporadic opportunities that arise in school sites' teaching-practices

classrooms. Compared to the traditional teacher preparation model, the Second Life's unique

structure is significant in assisting PSTs to acquire cultural knowledge and problem-solving

skills in both coursework and teaching-practice contexts with the support of university instructors.

Finally, this study focuses on the limited voices of preservice teachers regarding their experiences in teaching culturally relevant algebra lessons. Teachers described their own experiences in their own words. They had the opportunities to examine their own self-abilities and identities that are embedded in their interactions with students and examined the ways that students of diverse backgrounds learn and construct their knowledge. This contrasts with the traditional quantitative studies of PSTs that tell them their problems and how to change their teaching. Assisting PSTs to reflect on their own perceptions of cultural knowledge, diverse students, and instructional strategies is a unique alternative at promoting experiential and situated teaching.

Definitions of Terms

Several terms are defined to further clarify the nature of this study. I assume the following definitions:

Avatar: Avatars are animated characters with human capabilities. Avatars interact with each other and engage in conversations and computer programmed tasks in virtual worlds (Mirliss, et al., 2012).

Culturally Relevant Pedagogy (CRP): An approach to teaching and learning that "empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes" (Ladson-Billings, 1994, pp. 17-18).

Culturally Responsive Teaching (CRT): is defined as ''using the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant and effective for them'' (Gay 2010, p. 31).

Cultural Sensitivity: Attitudes, beliefs and behaviors towards students of other cultural, linguistic, and socioeconomic backgrounds (Larke, 1990).

Critical Pedagogy: Uses context and is defined as the "opportunities that all children have to benefit from classroom instruction" (Ladson-Billings, 1995b, p. 130).

Virtual Worlds: Online three-dimensional environments in which users communicate with others and construct their virtual surroundings (Mirliss, May, & Zedeck, 2012).

Second Life (SL): A powerful VWs technology tool that is available to support teachers in attaining and applying specific content knowledge to achieve equity in diverse classrooms (Davis, 2013).

Situated Teaching: Use of a realistic setting for students to have hands-on experiences to acquire mathematics knowledge and skills (Ladson-Billings, 1995a).

Summary

This chapter provides a brief overview of current trends in education, highlighting key data that are presented in more detail in later chapters. Topics outlined in this chapter include student enrollment in public schools, mathematics performance of students of color in comparison to students in more affluent schools. I describe the continuing effort of teacher preparation to promote equity teaching through teacher quality to enhance middle-grade mathematics learning. I identify the coursework and teaching practice problems in teacher preparation that have limited the abilities of PSTs to culturally relevant pedagogy in diverse classrooms. Further, this chapter describes three elements of culturally relevant pedagogy that identify the characteristics of successful teachers of African American students and how specific reform initiatives have dealt with the issues of teaching for equity. Addressing PSTs' quality is more than classroom instruction; PSTs need to be prepared and supported to teach mathematics

successfully in schools that experience poor mathematics performance. The persistent poor performance in mathematics that has existed for decades demonstrates that teacher preparation has not resolved these challenges.

A comprehensive teacher preparation program is needed to equip and support preservice teachers with the coursework knowledge and teaching practice experiences needed to provide adequate equity pedagogy for underserved students. This qualitative case study was designed to investigate the essence of preparing preservice with a focus on equity teaching in a comprehensive manner. In addition, this dissertation explores the purpose of the KATE study, its significance, assumptions, and limitations. Part of their effort was to strengthen effective approaches to mathematics instructions and the other part is to engage preservice teachers in teaching a critical thinking mathematics curriculum. Thus, the dissertation focuses on PSTs', their teaching practices of culturally relevant mathematics lessons and their perceptions of mathematics, themselves, underserved students, and teaching.

In the next chapter, I review the literature about the gap between coursework and teaching-practice and the ways in which teacher preparation have responded. I present the ways in which traditional teacher preparation programs have supported the development of PSTs to teach mathematics to underserved students. I provide examples of attempts to implement culturally relevant teaching in their mathematics instructions. I then describe how the KATE algebra problem-solving coursework and teaching-practice tried to bridge this gap.

Organization of Study. This study is divided into five chapters. Chapter one provides an overview of the challenges of preparing non-diverse PSTs for culturally diverse classrooms. I introduce the mathematics achievement gap, statement of problems, theoretical framework, teacher preparation limitations, virtual world, purpose and significance of study, research

questions and chapter conclusion. Chapter two is a review of the related literature. I draw on the framework that addresses models of culturally relevant teaching, which serve as a supplement to teacher preparation courses for diverse classrooms. I discuss the teacher preparation experiences that educators have implemented to encourage culturally relevant mathematics lessons. I then provide in-depth information about preparing teachers for culturally relevant teaching practice and the KATE teacher preparation model. Chapter three outlines the methods and procedures used in this case study. I explain the rationale for using a case study method and provide a description of the context of the KATE teacher preparation program and the participants. I discuss the data and a summary of the data analysis. In chapter four, I present the themes that emerge from the study of the eight PSTs enrolled in the integrated Mathematics and Science Algebra Method Course (MASC). I discuss the pressures that PSTs experienced and how they connected to the literature. In chapter five, I complete the dissertation with a discussion of important implications, and recommendations for future research in teacher preparation practices.

CHAPTER II

REVIEW OF LITERATURE

Introduction

This chapter provides literature review about preservice teacher preparation for public school classrooms. The review of literature is in lieu of the low achievement in advanced mathematics for students of color. This literature review is guided by the comprehensive approach that focuses on preparing teachers to teach for equity and work with underserved students in their communities. The primary focus is on instructional approaches that work towards increasing situated knowledge, culturally relevant and critical pedagogy knowledge, and problem-solving skills of teachers that make learning more effective for underserved students. The review further examines preservice teachers' perceptions of mathematics, students, culture, and approaches to teaching algebra for equity.

The chapter is organized into five sections. It begins with a brief discussion of the demographic changes in public-school enrollment and its effects on teacher preparation and the achievement gap. Next, the review looks at how the teachers' instructional approaches and perception of their experiences affects their lesson planning and teaching. The chapter introduces the KATE research project which is an exemplary program that uses virtual technology in coursework and teaching practice to prepare new algebra teachers for equity mathematics teaching. Finally, the chapter concludes with a summary

Demographic Enrollment Challenges

Data from NCES (2019) predicts a nationwide student increase rate of 3.2 in public school enrollment for a 12-year period from 2015 to 2027. In the states' changing student demographics, the state of Texas experienced an increase of 0.6 in 2018-19 from the previous

year. During the same period, 60.6 percent of students are identified as economically disadvantaged. The percentage of enrollment accounted for by White students decreased, and by African American students remained the same. For the 2017-18 school year (NCES, 2019) informs that 59percent of the 3.6 million public school teachers are White, about 41percent of the teaching workforce is comprised of minority teachers, which includes 10 percent African American, 27 percent Latino, 2percent Asians, and 2 percent other (NCES, 2019). In comparison the percentages of White teachers declined over the academic years, while the number of total teachers has increased. However, mathematics teachers in Texas remain predominantly female and White in the 2016-17 academic year. Larke's (1990) research study argues that because of the growing disparity between the two sets of demographics, educators need to increase their knowledge about equity related issues.

Mathematics Achievement Gap

There is no shortage of literature that highlights the gap in the achievement of underserved students in mathematics. Some claim that the key issue is the lack of experience of underserved students in mathematics and the need to educate teachers to implement culturally specific instructional approaches. The National Mathematics Advisory Panel (2008) reported that historically, teaching knowledge in mathematics, as measured by teacher certification and educational courses, has not shown significant changes in diverse student achievement. NAEP (2008) data comparisons of student achievement in mathematics indicate that underserved students often under-achieve compared to their White and more affluent counterparts. In literature review by Sleeter (2001, 2008), she acknowledged that research does not address the methods needed to populate the teaching profession with culturally responsive teachers. Sleeter

argued that mathematics data shows an undeniable pattern of inequitable achievement along racial and social class lines.

In the state of Texas, eight grade middle-grade basic-level mathematics achievement test scores increased; however, there are no significant changes in advanced-level mathematics achievement gap between White (16percent), Latino (4percent), African American (1 percent), and low-income students (NCES, 2019). Consequently, students who do not learn higher-level algebra problem solving skills in middle-grade will continue to struggle in mathematics throughout high school, which limits their preparation for college and careers in Science, Technology, Engineering, and Mathematics [STEM] areas (Brown et al., 2011). The Schott Foundation made similar projections based on data concerning the social consequences of the gap in mathematics achievement, which includes underemployment, health risks, lack of civic participation, and incarceration (Schott Foundation, 2009). Gay (2010) states that: "the consequences of these disproportionally high-levels of low achievement are long term and wide-reaching, personal and civic, individual and collective" (p. 1). Gay (2010) questions why students of color, who are successful in many different areas outside of school, fail in school, specifically, why so many students from underserved communities struggle to succeed in mathematics? Her conclusion is that unless educators can identify what is hindering academic performance of these students, the obstacles blocking high achievement cannot be removed (Gay, 2010).

Opportunity Gap

According to Darling-Hammond (2010), one of the major shortcomings of the reform effort towards mathematics learning is the failure to ensure that all students have access to the same opportunities to learn. The complex question is not the achievement gap but why the gap

exists. She states that educators need to frame the achievement gap as an opportunity gap and shift their focus to examining the learning experiences of marginalized students in their classrooms. The National "Opportunity to Learn" Campaign, by the Schott Foundation for Public Education, reported on concepts in the opportunity to learn using four components: high-quality early childhood education, highly qualified teachers in K–12 grades; college preparatory curriculum; and cultural instructional resources (Schott Foundation, 2009). They argued that the opportunity to learn is a complex construct that includes key resources (qualified teachers, funding, relevant and rigorous curriculum), as well as culturally relevant and meaningful tasks for students to understand. Gay (2009) has argued for similar components specifically for cultural instructional resources. Gay emphasized that:

> …accepting culturally responsive instructions as a requirement of quality education for ethnically different students, and crafting instructional actions that exemplify them are crucial components of teachers' preparation if they are to provide equitable learning opportunities for diverse students. (p.193)

To improve the learning opportunities for underserved students, efforts must be made to reform mathematics instructions to include opportunities for diverse students to learn.

Standards for Teaching Mathematics

The Council of Chief State School Officers [CCSSO], (2011) standards for teaching mathematics content states: an effective teacher must integrate specific content knowledge based on the strengths of students to assure that they all learn and perform at higher levels. Furthermore, "teachers need knowledge and skills to customize learning for learners with a range of individual differences" (p. 3) and consider their own backgrounds when making decisions about their students. Other standards convey similar views. The Common Core State Standards

Initiative [CCSSI], (2010) states that the teaching of mathematics emphasizes performing

relevant mathematics tasks that engage students, utilize a variety of teaching approaches, and

communicate high expectations in constructing mathematics knowledge. The approaches to

reach higher standards of mathematics teaching in public schools use multiple representations

(pictures, diagrams, demonstrations, models, and graphics) to communicate mathematical ideas

to students. Middle school teachers need to engage their students in the process of mathematical

inquiry and provide opportunities for students to explore and evaluate mathematical knowledge,

explain their reasoning, and make sense of other students' ideas.

The National Council for the Accreditation of Teacher Education [NCATE], (2008,

2010) standards specified that curricula and teaching practice practices be provided for teacher

candidates to improve their knowledge, skills, and professional dispositions about diversity to be

able to teach in diverse classrooms. Overall, NCTM (2000) argues that ''excellence in

mathematics education rests on equity—high-expectations, respect, understanding, and support

for all students'' (p. 11). NCTM (2011) recommends that the curricula should be based on

Active Inquiry, multiple representations and aspects of culturally responsive teaching.

Subsequently, NCTM (2011) developed teaching standards that include how students' cultural

and socioeconomic backgrounds influence their learning of mathematics.

However, those who promote culturally relevant teaching raise concerns about the

commitment to reform changes in mathematics standards and the transformation of learning

experiences for students (Davis et al., 2012). Gay (2013) asserts that teachers express concerns

that there is no time left for "teaching to and through cultural diversity" (p.59) due to the time-

consuming demands and expectations from academic standard mandates. Gay (2010) states that

teacher standards "seem to ascribe to a colorblind philosophy by avoiding any specific reference

to cultural diversity except for names of characters and "prompts for test items" (p. 138). According to Bob Moses in an interview with Joan Richardson (2009), the standards do not have strategies for accounting for kids who are at the bottom half and not making it through the system. This is not something teachers can solve by themselves. If teachers are sent into failing schools, they know in advance that the chances of them changing things are not there. Thus, the standards for good practices in teaching do not have enough in place to help teachers reach those standards. We need a system that supplies teachers with the skills and ways to do those skills. We need a diverse teaching population to be able to establish different routes. Teachers need to be prepared for the work of teaching and skilled in helping all their students learn.

Teacher Perception

The contextual factors that affect students' academic achievements are teacher perceptions, teacher quality, instructional resources, and the teacher preparation programs they attend (Gay, 2009). Gay (2009) asks: "How can middle-class, monolingual European-American math teachers work better with students who are predominantly of color, attend schools in poor urban communities, and are often multilingual?" Many teachers are reluctant to embrace the reality of cultural differences between themselves and their students; and as such are unwilling to incorporate the realities of these students into their classroom practices. It is easier for teachers to forget that student achievement in school depends on what happens outside of school (Gay, 2010). Gay (2000) argues that those who help students learn mathematics should identify the obstacles (e.g. social-economics and schooling contexts) that either hinder their students' academic performances or facilitate their learning. Gay's (2009) research indicates that teachers' beliefs about mathematics, students, and teaching influence their knowledge acquisition, curriculum, and classroom practices.

Preservice teachers should develop culturally relevant knowledge to (1) confront and modify their traditional beliefs about culture and mathematics, (2) increase their cultural knowledge about the contributions of ethnic individuals to mathematics; and (3) develop guided practices to transfer what they have learned to teach students of diverse backgrounds. Gay (2009) identified four types of perceptions that hinder teaching diverse classrooms: perception of mathematics, self -identity, students, and teaching.

Perception of mathematics. Many preservice teachers have traditional beliefs and attitudes about mathematics, which include limited self-beliefs about their ability to learn and teach mathematics (Boyd et al., 2014). PSTs' experiences as students in mathematics classrooms shape these beliefs and attitudes. According to Itter and Meyers (2017), preservice teachers come from an education system that shapes their own mathematical perceptions and the perceptions of their students' mathematical abilities. Unfortunately, many develop negative perceptions about mathematics and students. Itter and Meyers (2017) investigated the attitudes of 152 third year preservice teachers using their written reflections about mathematics. To understand the consequences of negative mathematical perceptions, they focused on the responses of 111preservice teachers who acknowledged having negative perceptions about mathematics. Their findings confirm that these perceptions affect their levels of motivation, engagement, and their learning approaches, and these effects shape how preservice teachers teach.

The relations among teachers' mathematical knowledge, the quality of their teaching, and their students' performance is important. Ball (1990a) interviewed and gave questionnaires to 252 elementary and secondary school preservice teachers and found that their understanding of mathematics was strict with rules and guidelines. Ball's (1990a) findings indicate that even teachers that described mathematics teaching and learning as interactive, "hands-on," and

evolving continue to use traditional teaching approaches of isolating content, give directions, and assign practice work. Teachers' perceptions of mathematics have strong effects on their abilities to follow teaching practices that are engaging, active, and that makes connections between the learner and subject matter. Ball (1990a) concludes that teachers who are committed to their learners' success but use conventional approaches to teaching, often experience difficulties in creating meaningful, constructive learning.

In an interview with Joan Richardson in 2009, Ball expressed her view that, mathematics teachers need a different set of experiences and specialized skills such as ethical commitments and mathematical teaching knowledge. Teachers are not hearing their students' mathematical thinking. Students are doing all kinds of mathematical things that teachers are missing, which has everything to do with students' failure in mathematics. In her experience, Ball found that kids will say interesting things and their teachers will say, '"No, don't do it that way" or "We're not talking about that" or "That has nothing to do with what we're talking about"'(Richardson, 2009, p.3). Students are just using symbols, but nobody is explaining all about it. Teachers need to be taught to hear and notice what students are saying and doing. Algebra needs to be explicitly taught so that students can generalize it to other areas.

Teachers often come to the classroom with preconceived ideas about mathematics as culture free (Ernest, 2009). Consequently, this perception of mathematics is separated from the everyday experiences of most students. This view suggests that advanced level mathematics curricula is accessible to a few select groups of students, which in turn privileges them and disadvantages others (Ernest, 2009). Gay (2009) added that teachers' perceptions of mathematics have become a proxy for academic inequities in educational opportunities and a means to perpetuate a class system of "haves" and "have nots" (Gay, 2009, p. 194). For example, algebra

is referred to as the "gatekeeper" and taught as a precursor to advanced levels of mathematics; however, large numbers of underserved students are excluded from having access to advanced algebra learning beyond basic skills. Moses et al., (2009) argue that advanced level mathematics learning is for everyone, and it is not useful to deny or focus some students on basic skills.

Perception of self-identity. Teacher education research for the past three decades has sought to find effective ways to prepare preservice teachers for public classroom teaching. de Freitas (2008) asserts that a significant obstacle to preservice teachers' development is "mastery identity" (p. 44). To broaden their perceptions, de Freitas (2008) calls for an examination of their "mastery identity" (p. 44) to recognize the sociocultural factors that contribute to their own success and careers as mathematics teachers. de Freitas' (2008) notes that teachers' understanding of the intersections between their own experiences in mathematics and the cultural frame of those experiences has a positive effect on student's teaching. He believed that self-examination of their own experiences in mathematics has the potential to benefit them to gain awareness of the intersection between mathematics and culture. He insists that preservice teachers reflect on their own personal experiences, including their assumptions and biases because the "cultural framing of those experiences" (p.50) may contribute to their understanding of underserved groups of students. de Freitas (2008) suggests that preservice teachers recognize the crucial role that external factors play in education if they are to address them in their classrooms.

Reiter and Davis (2011) argue that diversity in teaching is limited because teachers' attitudes, values, and beliefs shape their instructional and learning behaviors. Nieto (2004) stated: "our public schools are unsuccessful with many students, primarily those from racially, culturally, and linguistically diverse and poor families" (p. 2). Students are expected to abandon

their own cultural beliefs, unique experiences, and learning styles to assimilate with their teacher's experiences. However, teachers are not confronted with their own cultures, perceptions, beliefs, and attitudes about students' backgrounds that make them unable to teach these students (Nieto, 2004). Gay (2000) added that teachers' cultural attitudes, beliefs and expectations enhance or hinder the mathematics instruction of marginalized children. For example, preservice teachers will draw on their prior mathematics experiences and social behaviors without realizing how incompatible their experiences are to diverse classroom practices (Gay, 2010). So, to better serve the needs of all students, teachers need to recognize and examine their own personal beliefs and existing biases, however, preservice teachers will not question their own views unless prompted to do so.

Hollins and Guzman (2005) provided evidence of differing perspectives on the issue of diversity. The study described how these perspectives are influenced by the teachers' personal experiences and views. Hollins and Guzman' (2005) literature review noted that a large body of studies focus on understanding preservice teachers' attitudes, beliefs, predispositions, and prior experiences with diverse groups. These studies examine the extent to which culturally relevant coursework and teaching practice s have changed preservice teachers' attitudes and beliefs toward cultural awareness. The research shows the point at which teachers integrate cultural concepts in their practices. Sleeter's (2008) review of research presented the same idea that educators assist preservice teachers in examining their perceptions, beliefs, and attitudes as a first step to further understand diverse cultural practices and perspectives. Preservice teachers should learn to understand their students' experiences and engage in the process of constructing, deconstructing, and reconstructing concepts during the learning process. Sleeter found that

(a) Courses that demonstrated positive results use multiple strategies, such as engaging

preservice teachers in self-reflection and preparing lesson plans that implement cultural

knowledge and teaching practice s throughout the program. Such courses also engaged

preservice teachers in discussions about poverty and discrimination and help share their

perspectives and preconceived assumptions about other groups.

(b) Teaching practice s placed preservice teachers in school settings that were culturally

different from their own settings and engaged them in investigating activities and

reflections that prompted them to examine their prior beliefs.

However, neither study identified the specific experiences during the practicum that changed

preservice teachers' attitudes and beliefs about diverse students.

Perception of underserved students. Given the demographic mismatches between

teachers and students, content knowledge and pedagogical knowledge are vital for teachers to

develop, but beyond these two forms of knowledge, a third form is knowledge about diverse

students (Gay, 2009). Villegas and Lucas (2002) noted: "most [in-service] teachers and

prospective teachers have no windows into the lives of increasingly greater numbers of their

students" (p. 22). They do not share the same frames of reference to make meaningful

connections between classroom instruction and the cultures, lives, and experiences of students.

Capraro et al., (2009) posited:

Students of color are often challenged by the instructional practices presented by White

teachers unfamiliar with their students' cultural backgrounds. This result coupled with

cultural differences that are exasperated in many traditional classrooms may inhibit the

ability of many Black students from mathematics excellence. (p. 50)

Powell-Hobson and Hobson (1992) posits that a teachers' perceptions of a student lead directly to their expectations of the student. If the teacher perceives the student as intelligent, then he or she will expect above average work from the child (p. 54). Consequently, if students are perceived as unintelligent, they will receive watered down versions of the curriculum or be excluded from advanced level mathematics enrollment.

In another example, McDiarmid and Price (1990) recapped that teachers teach based on their knowledge of learners, pedagogy, subject matter, and social context. McDiarmid and Price's (1990) research used a questionnaire that evaluated PSTs' beliefs on teaching mathematics to students from different achievement levels. To learn more about the PSTs' thoughts of culturally diverse learners, McDiarmid and Price's (1990) study evaluated a PSTs research program focused on Accepting Behaviors for Cultural Diversity (ABCD). The authors investigated "how student teachers think about teaching and learning in culturally diverse classrooms" (p. 2) and how the ABCD training influenced their fundamental beliefs. The program was designed to provide teachers with the knowledge and skills needed to teach students from culturally diverse backgrounds and to view cultural diversity as an asset. Their findings revealed that PSTs believed in differentiating instructional practices and would teach mathematics differently to high achieving students compared to low achieving students. Student teachers justified this belief by explaining that higher cognitive task instructions are more appropriate for high achieving students, whereas fun mathematics instructions are appropriate for low achieving students. McDiarmid and Price (1990) concluded that the ABCD training made a small impact on PSTs' beliefs about underserved students. After training, there was a slight shift in PSTs' perception about the idea that all students can learn, and they rejected the notion of stereotyping underserved students.

Teachers sometimes develop misconceptions about students that fit their own experiences. Ladson-Billings (1994) argues that the way underserved students are perceived by their teachers makes it possible or impossible for them to receive equal learning opportunities. For example, deficit thinking based on common stereotypes that students from certain ethnic groups do not perform well in advanced level mathematics because of their home experiences and cultures. Ladson-Billings (1994) explained that this thinking promotes negative attitudes towards students, which also interferes with the effective teaching of these students. Without intervention, teachers' false beliefs about students will resurface through their attitudes and behaviors towards teaching them, including stereotypes practices (Gay, 2010). Ball and Cohen (1999) state that "teachers would need to learn that knowing students is not simply a matter of knowing individual children" (p. 9). Teachers need to become acquainted with cultural differences, including differences in learning style, language, socioeconomics, family, and community.

Cultural communication. Gay (2000) stated that teachers expect all students to behave according to their classroom's cultural standards. For example, non-diverse teachers are generally accustomed to a passive-receptive call-and-response pattern of communication in the classroom. They expect students to listen quietly while the teacher is speaking, and then respond individually to teacher-initiated questions. However, other cultural groups traditionally expect "active-participation" in which they provide comments and reactions at will. Particularly, Gay (2010) stated, "Communication is strongly culturally influenced, experimentally situated and functionally strategic" (p. 125). African American students come from a rich history of oral communication that is expressive, participatory, interactive and multidimensional. They expect to be engaged in conversation and give feedback about their thoughts. Sometimes, this conflicts

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with the teacher's pattern of communicating and presents a problem in the classroom where teachers expect students to listen and take turns speaking. Therefore, teachers who are unfamiliar with this communication style may consider these students disruptive, rude, and distracting. Gay asserts that, culturally responsive teachers understand their students' communication needs and seek not to eliminate cultural markers but find ways to teach students based on their cultural backgrounds. Preservice teachers need to know more about the communication styles of their students to promote classroom communication effectively.

Culturally relevant pedagogy necessitates that teachers learn about students, their cultures, and backgrounds (Ladson-Billings, 1997). Ladson-Billings (2000) suggests that educators increase preservice teachers' knowledge of underserved students by: 1) providing opportunities for them to learn the central role that culture plays in learning, 2) engage preservice teachers in practical teaching in a controlled environment, and 3) assist preservice teachers to critique the inequality in the classroom. Enhanced knowledge of students helps new teachers to differentiate four areas that are relevant to understanding students' learning processes: (1) preexisting knowledge, (2) active engagement, (3) multiple representations, and (4) situated learning. Kulm et al., (2011) asserts that PST's knowledge of underserved students is the basis for teaching algebra lessons. Teachers need to know about students' experiences outside of the classroom to incorporate their cultural interests into the lesson plans (Ladson-Billings, 1994). Gay (2010) explained that teachers as well as students should bring their personal cultural identities into the classroom to influence how they see each other. Gay (2010) argues that for [children of color] to be taught effectively, teachers need to have some knowledge of students' communities and be careful of generalizations and assumptions about their cultural practices. Gay (2010) expresses concern that the perceptions of underserved students are grounded in facts

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and may "persist even after new models have been taught that contradict their prior understandings" (p. 64). Teachers need to acquire knowledge relating to the communication patterns, language, interaction, and cultural practices in student communities if teachers are to make connections between the mathematics content and the existing knowledge of students.

Perception of teaching. Standards for K–12 mathematics calls for middle school teachers to regularly engage their students in the processes of mathematical inquiry by providing opportunities for students to explore, explain their reasoning, and making sense of other students' ideas CCSSI, (2010). Research shows that these experiences have a positive influence on students' problem-solving abilities, reasoning skills, and thinking processes. It exposes students to different ways of thinking about and solving problems and improves their ability to generalize mathematics. Typically, teaching is focused on a narrow concept of mathematics knowledge and pedagogical knowledge (Shulman, 1987). As articulated by Ladson-Billings' (1994, 1995a, 1995b, 1997) research, the purpose of culturally relevant teaching is to help students achieve academically, culturally, and socially. Ladson-Billings (1995a) proposes a broader concept of teaching mathematics from the perspectives that include all cultural groups and that provide access to higher-level mathematics courses that increase opportunities for underserved students. This broader definition of teaching is termed "good teaching" because it acknowledges what takes place inside and outside of the classroom. Ladson-Billings (1995a) outlines various instructional approaches, such as contribution/relevance, transformation, and social action, which are critical for teacher candidates to acquire tools that engage students in problem solving. Her framework of culturally relevant pedagogy calls for teachers to "incorporate the required curriculum and associated academic responsibilities with issues of

social justice" (Ladson-Billings, 2001, p.120). She suggests that teachers' perceptions affect how they implement culturally responsive teaching practices in the classroom.

Kennedy (1999) argues that teachers start from a frame of reference in teaching and learning. Often their experiences are limited in teaching underserved students in public school systems, but rarely do they recognize this on their own (Kennedy, 1999). As a result, they pay attention to the familiar aspects of knowledge that align with their own past experiences or mimic the practices of teaching and learning that are familiar to them. Kennedy (1999) calls this the "Problem of Enactment," which describes the difficulty that new teachers experience when they transfer what they learned in their coursework to practice. For example, some teaching-placement classrooms give PSTs a new frame of reference to interpret the classroom situations they observe, but most PSTs interpret these new situations using the same frames of reference they already have. Kennedy (1999) added: "Besides the training strategies of videos, case studies, and other representations of practice to support situated knowledge, teacher candidates may not interpret the situations they observe in terms of important ideas of culturally relevant teaching" (p.75). So, teacher preparation programs must alter PSTs' frames of reference to expand their concepts of teaching and learning (Kennedy, 1999).

Leonard et al., (2009) assert that linking mathematics and culture is a problem for many teachers. Leonard et al., (2009) state that ''the enactment of [culturally relevant pedagogy] in mathematics classroom is complex and may contradict teachers' beliefs and assumptions about the nature of mathematics, how it is taught, and the teacher's role and identity as these relate to teaching underserved students'' (p. 3). In addition, if teachers are unable to explain why a procedure works, students' mathematics misconceptions become stable (Kulm et al., 2016) and interfere with their learning of basic algebra problems. So, to prevent and correct students'

misconceptions, teachers' misconceptions must be corrected first. Well-prepared teachers who recognize their own mathematical misconceptions are essential for teaching mathematics equitably (Kulm et al., 2016). Preservice teachers cannot help students overcome deeply rooted misconceptions if they do not realize their own.

Mathematics and Culture

The broader view of mathematics is grounded in cultural and problem-solving practices (Swetz, 2009). According to Frank Swetz, "If the logic of our language and thoughts does not fit the logic of mathematics, there will be learning difficulties" (p.37). Culture often expresses itself in the classroom through students' questions such as: What is this good for? When am I going to use it? (P. 30). Swetz (2009) stresses: "history shows that no aspect of mathematics is free from cultural influences" (p.38). Therefore, any discussions about students' mathematics performances must identify cultural traits that promote learning attitudes and motivation because culture affects the way we think, learn, and teach mathematics (Swetz, 2009).

Similarly, Ernest (2009) argues for new perceptions of mathematics along with new teaching approaches that help students develop mathematical capabilities, confidence, and appreciation. His argument is that mathematical knowledge is not culturally free but has a historical footprint in cultural values, preferences, and interests that cannot be discounted. The cultural perspective of mathematical knowledge is socially constructed and forever changing (Ernest, 2009). So, mathematics curriculum should consist of more than abstract knowledge and include a broad range of practices constructed through specific cultural and social contexts. Teaching mathematical concepts is essential to solving real and everyday problems.

Ukpokodu (2011) argued that over the years, the dominant teaching practice in mathematics education for "minority" students followed a traditional approach based on linear

thinking of right or wrong answer shots. However, mathematics learning is not free of cultural influences (Ukpokodu, 2011) and connects to the problem-solving styles, motivation, and interest of students. Without this connection, the mathematical problems that students solve in the classroom are perceived by students as irrelevant to their lives. As a multicultural educator, Ukpokodu examined why teachers are not integrating culturally relevant topics in their teaching lessons. In her qualitative graduate course study, participants were both pre-and in-service teachers enrolled in "Teaching and Learning in Urban Classrooms" at a university in a large urban community. Forty-five participants enrolled in the study: Thirty-five were Whites, eight were African American, one was an Asian American and another was an Asian international student. The course aimed at assisting participants to investigate an alternative framework that offer new visions for urban students. It was meant for teacher participants to understand that mathematical knowledge "is situated within a sociocultural frame of a given cultural group" (p. 51).

The data collected included classroom activities, online discussions and the researcher's teaching notes. In the first research activity, teacher participants were asked questions about culturally responsive practices in mathematics. In the second activity, participants were assigned into groups to read, identify, and summarize culturally responsive mathematics teaching practices. The study's findings revealed that "teachers' critical consciousness, advocacy, and activism" (p. 54) and other elements of culturally responsive mathematics teaching were lacking (Ukpokodu, 2011). First, teacher participants did not enact culturally responsive teaching because of their "view of mathematics as culturally-neutral" (p. 50). They perceived mathematics as having little to no meaning in life experiences. So, they paid little attention to integrating the cultural experiences of students into their mathematics lesson plans. In addition, teacher

participants explained that "mathematics is an abstract subject, a 'universal language,' numbers are the same across time, culture, and space, and therefore, mathematics instruction does not have anything to do with culture" (p. 50). Second, teacher participants mistakenly believe that special efforts are made to "fit in" culturally diverse material in the curriculum. They mentioned the convenience and dominance of textbooks for mathematics as a major factor that interferes with the use of culturally responsive approaches.

      Cultural context. Grossman (1990) defined the "knowledge of context" as the understanding of the environment in which learning happens (p. 9). Grossman claims that it is pointless for educators to promote the success of students by expecting them to divorce from their cultural heritage. Culturally relevant pedagogy takes the position that all knowledge is socially constructed and not culturally neutral or free. Ladson-Billings (1995c) discusses the importance of cultural context within a mathematics curriculum because it enables students to learn within their own culture. Culture denotes "deep structures of knowing, understanding, acting, and being in the world" (Ladson-Billings, 1997, p. 700). This means that the dynamic system of "culture determines how we think, believe, and behave, and these in turn, affects how we teach and learn" (p. 9). She suggests that instructional practices affirm students' cultural dignity, mathematics understanding, and their ways of knowing mathematics topics. For example, in the algebra study that Ladson-Billings (1995a) conducted with successful teachers of African American students, she observed that teachers set the context of the algebra lesson by informing African American students about the origins of the subject. This approach allowed students to ask and answer questions posed by the teachers who served as facilitators. Culture is always influenced by who, when, and why and for whom and what purpose (Gay, 2009). Gay (2010) gave three reasons why culture should be considered in mathematics:

Real life cultural experiences give relevance to mathematics learning.

Using cultural examples in the curriculum allows students to construct their own

knowledge.

Using cultural contexts serve as bridges to new mathematics learning.

Teachers need to understand how and why culture is an essential foundation of teaching

mathematics, because mathematics learning does not exist outside of cultural influences (Gay,

2009). Culturally responsive mathematics teachers believe that attention must be given to how

mathematics is taught, why it is taught, and what knowledge is required to create culturally

relevant lessons (Gay, 2002). Gay (2010) stated that:

When academic knowledge and skills are situated within the lived experiences and

frames of reference of students, they are more personally meaningful, have higher interest

appeal, and are learned more easily and thoroughly. (p.106)

Gay (2013) argues that culture is neither inherently good nor bad, but it must be understood

within context because it is present in everyday activity.

The differences in culture can be translated into different classroom values, expectations

and priorities between teachers and students. These differences in views can create barriers to

student success (Banks, 2006). For example, a teacher might emphasize competitive learning to

increase engagement from their students. Students from different cultural backgrounds may favor

collaborative approaches instead and find the competitive strategies to be marginalizing. To

Banks (2006), a major obstacle to empowering African American students to learn mathematics

is the failure to provide a culturally responsive curriculum that is influenced by their experiences

and culture. Banks (2006) assess that learning should be relevant and meaningful to students and

serve their needs because their culture, personal knowledge, and learning styles are taken in

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account. Students are more motivated when they see meaning in what they learn, and the information is useful for something that impacts their lives. Additionally, teaching practices that utilize a cultural curriculum create more access to learning opportunities where students see themselves and their backgrounds represented in the classroom, which makes them more likely to engage in learning (Banks, 2006). Teachers who understand the impact of cultural contexts in learning use it to create effective curricula content for them (Banks, 2006).

Bridging School and Home Knowledge

Connecting mathematics with students' cultural knowledge is important to improve mathematics learning (Lipka et al., 2005). Lipka and colleagues used what students already knew about their community to build their mathematics curriculum. Lipka et al., (2009) states that transformation occurs when school knowledge that separates from community knowledge is re-contextualized and taught in a culturally based curriculum built on the foundation of what students bring to the classroom. Lipka et al. (2009) research restructured mathematics knowledge in a social cultural context of indigenous Yup'ik Indian craftsmanship of pattern weaving to teach mathematics to Yup'ik children. Their study described a two-way process of supplementing a mathematics curriculum for elementary school learning called "Math in a Cultural Context (MCC)." MCC was a 20-year collaborative initiative with Alaskan Yup'ik Eskimo community natives and educators to restructure the mathematics curriculum. According to Lipka et al., (2009):

> It was a partnership to find ways to change schooling to include this knowledge (content and processes) for the purpose of making learning more meaningful to students, thereby improving their ability to think, solve problems, and identify with their local culture. (p. 265)

Thus, MCC was intentionally designed to embrace Alaskan children's identities, increase their access to learning opportunities, and present multiple ways for them to engage with content. Teachers coordinated the social and cultural capital of Navajos' Yup'iks as a resource to improve student understanding of mathematics. Culture and mathematics are woven together to form a culturally relevant content to improve mathematics learning. The purpose of the transformative curriculum was to combine Yup'ik' culture and mathematics for students to learn algebra using indigenous patterns, shapes, and crafts.

Educators observed demonstrations and listened to the historical and cultural knowledge of elders' as they explained their practices. During their collaboration, teachers learned that Patterns and Parkas were designed exploring shapes and areas. Lipka et al., (2009) realized the connection between parka patterns through traditional stories and their way of using symbols to represent their ideas, expert apprentice modeling, group production activities, and cognitive apprenticeship. For example, they learned how to make a circle out of a square. Thus,

> "issues of culture, power, and creativity are woven together to form a newly re-contextualized content and an environment that surrounds learning that content without losing sight of the critical importance of improving students' math learning" (p.266).

Furthermore, Yup'ik cultural patterns of communication and storytelling activities identify with the curriculum and increase access to algebra. The Yup'iks' contextual knowledge sets the curriculum in familiar ways that include communication patterns and social beliefs in the community. The curriculum is composed of everyday activities of Yup'ik culture that are presented in ways that are apparent and measurable. The curriculum included how Yup'ik people designed patterns and applied them to clothing. Students were to investigate geometric principles, angles, patterns, and area.

In addition, Lipka et al., (2009) found that these students developed mathematical problem-solving skills based on patterns, shapes, and other elements associated with cultural decorative patterns and development. Teaching in a cultural context familiar to Alaskan Native students captured their interests and enhanced their involvement (Lipka, et al, 2005; Lipka, et al, 2009). By using cultural tools to learn mathematics, the MCC students outperformed students using the regular curriculum. Lipka et al. (2009) concluded that the integration of culture and mathematics engaged students in a learning process to:

Access high quality learning and multiple ways to engage with the content

Have a positive affirmation of their identities.

Connect insider and outsider knowledge.

Meet both their mathematics requirement and state standards.

This approach is supported by evidence from Ladson-Billings (1995a) research that shows that including community knowledge in the curriculum makes a difference in students' learning. Bringing in situated knowledge from the Yup'ik elders into the MCC curriculum bridges the gap between school mathematics and community knowledge.

Teaching and Learning Mathematics

Gay (2009) questions: (1) How can mathematics teaching be more culturally responsive for ethnical diverse students and be more effective? (2) How can middle-class White mathematics teachers work better with students of color and low-income students? These questions are related to discussions that are fundamental to effective teaching and learning. Gay (2010) reflects the challenges for preservice teachers who have fewer examples of what culturally responsive teaching means to be expected to close the opportunity gap and hence, the achievement gap. Gay (2010) noted that teaching and learning are "multidimensional and

constantly changing" (p. 10). Therefore, teaching and learning in a culturally diverse classroom represents multidimensional tasks that encompass curriculum content, learning contexts, and instructional techniques. The goal for teaching and learning is for all students to win, not for some to win and others to lose. The teaching and learning process have many: conventional, situated, critical pedagogy, culturally relevant, and technology-enhanced approaches that have been used in the past.

        Conventional teaching. Mathematics is learned best when it is encountered and when students care about the subject matter. However, instructional practices in mathematics have focused on conventional teaching methods that favor linear thinking instead of inquiry thinking. The way that mathematics is taught in K-12 public school classrooms creates a disconnect from the real-life experiences of many students. When mathematics is presented in the form of decontextualized formulas and abstractions, students find it difficult to see the relevance of mathematics concepts, principles, and operations to their real lives. Limitation in these methods have contributed to academic difficulties for students of color (Brown, et al., 2011). Gay (2010) stated: "educational equity and excellence for all children are unattainable without the incorporation of cultural diversity" (p. 13). The conventional practices of mathematics teaching create barriers for teachers because learning is shaped by cultural and social values, conventions, and assumptions (Gay, 2010). Gay (2010) asserts that cultural content is needed to connect mathematics curricula to students, so they become successful. Teachers who rely on conventional teaching practices in public schools do not capitalize on the cultures that students bring into the classroom. The act of teaching must be situated within the cultural and historical context of the learners. Drawing upon Ladson-Billings' (1995b) definition of culturally relevant

pedagogy as the "opportunities that all children have to benefit from classroom instruction" (, p. 130).

Darling-Hammond (2010) expresses concern that teaching practices deny equal opportunity access to mathematics learning for marginalized groups of students. A curriculum that supports critical thinking, problem solving, communication, collaboration, and applications of knowledge to real-world problems is essential. Yet, a "thinking curriculum" is typically reserved for a minority of students who are in affluent suburban schools. Teacher training is needed to offer a more challenging curriculum to diverse groups of students. This teaching demands special skills to scaffold and differentiate instruction, make content accessible to diverse learners, and engage in productive project-based instruction. If equality is to be achieved, it is critical that teachers enter the profession with skills and awareness of how equal access to learning is structured in the classroom. Equal opportunity means viewing differences as normal and not in a way that hinders the students' ability to achieve success (Darling-Hammond, 2010). In addition, the implication for practice requires adaptations in specific classroom and teaching practices. Teacher educators can increase student-teacher connections, better attitudes, and better outcomes.

Teacher preparation in the past decades has concentrated on improving pedagogical knowledge and mathematics knowledge. Hill, et al., (2008) argue that elements of Pedagogical Content Knowledge (PCK) are fundamental to what teachers teach and how well they teach mathematics, which include content knowledge, pedagogy knowledge, diverse student knowledge and constant reflection and revision of the curriculum. These elements of PCK "allow teachers to engage in teaching tasks, including how to accurately represent mathematical ideas, provide mathematical explanations for common rules and procedures, and examine and

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understand unusual solution methods to problems" (P.377-378). The impact of PCK is critically

important in defining how teachers construct meaning for their teaching roles and tasks. The

NCATE (2010) report voices concern for the state of teacher cultural knowledge in the context

of the growing diversity within public schools. NCATE (2008) provides recommendations to

close the gap in teacher preparation by including standards for cultural knowledge awareness.

Preservice teachers are required to:

> operationalize the belief that all students can learn; demonstrate fairness in educational
>
> settings by meeting the educational needs of all students in a caring, non-discriminatory,
>
> and equitable manner. (p. 7)

Lesson planning means integrating theories and beliefs that assist in teaching. Ball et al.

(2007) found that preservice teachers follow procedural scripts when planning lessons. They

consider outside influences, past experiences, technologies and other materials in their

instructional plans (Ball et al., 2007). However, Tyler (2013) contradicts this finding that most

PSTs connect the curriculum to their students and modify it to their needs. The differences in

these planning techniques is connected to the participants' development during their practicum

and their interactions with students.

Siwatu et al., (2009) administered a self-efficacy instrument to 104 preservice teachers to

examine their beliefs about culturally responsive teaching in their classrooms. These preservice

teachers already completed two courses on cultural diversity and one teaching practice. Their

findings revealed that most preservice teachers (87 percent) said that they can work in public

schools after taking courses on cultural diversity and teaching practice. However, they indicated

low self-efficiency as an obstacle to integrating culturally responsive curriculum in their

practices. Mathematics preservice teachers indicated low ability when integrating cultural

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contributions of diversity into their lessons. This outcome led researchers to conclude that preservice teachers are less likely to incorporate critical aspects of culturally responsive teaching in their classrooms. However, it is not simple to determine how the program influenced their responses.

Guillaume and Kirtman (2010) assert that teachers are products of the educational system as students and subsequently as teachers; they tend to teach the way they were taught. So, while new teachers seem to take up equity stances towards teaching underserved students, it is often difficult for them to organize important cultural content that affect student learning outcomes on their own. Guillaume and Kirtman (2010) investigated the experiences and perceptions that PSTs brought into their teacher preparation programs and how they saw themselves as teachers. Guillaume and Kirtman (2010) stated that "teachers are products of the school system that they pass through as students and re-enter as professionals" (p. 124). Teachers may know how to teach but tend to teach using the methods that they were taught. Teachers who are characterized as "good teachers" tend to create safe classroom environments for students, meaningful curriculum content, engage in active learning, and teach for social justice and understanding. These teachers believe in their students' abilities and "show the connections between mathematics and other facets of life" (p. 138). Many teachers focus their teaching on finding the correct answers even after they have "reform-minded curricular materials" (p. 133).

Kulm et al., (2016) focus on common misconceptions PSTs make when implementing their lesson plans, which includes their focus on factual rather than conceptual knowledge and their inability to engage students during teaching practice. In addition, Mutton, Hagger and Burn (2010) found that PSTs develop strengths in designing learning tasks and using learning materials, but they have less success when implementing their lesson plans. They are unable to

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engage students because of their ineffective time planning, lack of experience, and limited exposure to students. These problems challenge the abilities of PSTs to solve issues of culturally relevant teaching compared to the traditional lesson teaching.

Cohen and Zach (2013) explained that student-centered lessons require new strategies, and the brief nature of teacher preparation hinders PSTs' confidence in developing these knowledge and skills. On the contrary, in traditional teacher-centered lesson planning, PSTs experience fewer student issues and feel more comfortable with planning lessons for teaching practices. A limited number of studies have demonstrated how teacher education programs prepare PSTs for integrating student-centered methods into teaching practices.

Situated learning. Khisty (1995) argues that students must understand how to interpret the problem-solving questions before they turn to solving algebra formulas; so, underserved students must learn proficiency in mathematics communication. Kristy provided evidence that underserved students often encounter learning challenges because they are not familiar with the context of language and mathematics. Phrases that teachers take for granted are confusing to students with limited English language proficiency. For example, while the word left as in, "how many are left?" in a subtraction word problem (Khisty, 1995, p. 282) is not difficult to understand for native English speakers, the context of the word "left" is also associated with direction. This instruction may be unclear to underserved students who are unfamiliar with multiple contexts of the same word.

Since there are multiple meanings and phrases in the language of mathematics, students must be familiar with the appropriate contexts in which words are used. Khisty (1995) suggests that in diverse classrooms, the teacher should pay attention to the students' interpretations of words and their usages. The use of unfamiliar words in problem solving leads to misconceptions

and mathematical errors. Khisty recommends strategies such as "recasting" (p. 284) or restating of mathematical terms in different contexts and emphasizing meaning through voice variations to make it possible for all students to understand. Teachers need to consider the depth, complexity, and richness of students' learning and interpretations of mathematics concepts.

Many students are unable to translate "academic math language" into practice or apply the language of classroom mathematics to their social backgrounds (Gay, 2009, p.195). Turning a question into a mathematical formula is difficult if students are not familiar with the context upon which instruction is based. Mathematics language does not make practical sense to students if the content does not relate to everyday life. Instructional practices must be situated within the cultures of students so that the sociocultural characteristics benefit the student populations (Gay, 2010). Thus, situated mathematics teaching requires two notions of knowledge: specific mathematics knowledge and the engagement of students in the active construction of knowledge, also known as "to do" or "hands-on" knowledge. Preservice teachers must develop situated knowledge that interprets events in context and not in abstraction. Preservice teachers need to understand the ways that students work within their own "cultural frames of reference" (Gay, 2010, p. 26). Gay added that situated knowledge has proven meaningful in classrooms because learning is situated in meaningful, everyday context that connects to students' experiences and empowers them to participate actively. Unless PSTs have situated knowledge and pedagogical mathematics knowledge, they will not impact the kind of learning outcomes expected.

The situated perspective describes behavior that is "oriented toward practical activity and context" (Pellegrino et al., 2001, p. 62) and summarized as contextualized in a process of everyday social action, engagement, and communication. The NCTM (2011) standards suggest that instructional approaches engage inquiry-based cooperative learning that include evaluating

strategies, resources, and feedback. Active teaching methods engage students in questioning, interpreting, and analyzing information in the context of problem solving that is interesting and meaningful to them. Brown, et al., (2011) discusses a five-year National Science Foundation project to test virtual technology-based teacher training, which introduces equity in algebra studies for underserved students. They suggest a focus on situated knowledge that combines specific mathematical knowledge and the understanding of underserved learners. Enhancing situated knowledge is designed to help students connect what they have learned in the classroom to their everyday experiences within their communities and other non-school environments. In summary, mathematics learning cannot be reduced to teaching isolated facts but must include specific contexts in which facts are useful and relevant. Mathematics learning is not simply figuring out how to get things done, but what to get done, why, and to whose interests it serves.

Culturally Relevant Teaching

Central to teaching is the belief that culture matters and has an influence on teaching and learning (Gay, 2010). Gay noted, the very act of teaching requires many students to deny their personal culture and linguistic heritage. Teaching approaches cannot exist outside of the students' cultures because students use their prior knowledge and beliefs to make sense of new knowledge. Teachers need awareness that there are differences and similarities among students, such as communication styles, expressions, and gestures, relevant for classroom teaching and learning. Gay (2010) attributes the characteristics of culturally responsive teaching as comprehensive, multi-dimensional, empowering, affirming, transformative, and emancipatory. She states that, the fundamental aim of culturally responsive teaching is to empower learners "through academic success, cultural affiliation, and personal efficacy" (Gay, 2010, p. 127). It is a strategy that combats the learning inequities which are prevalent along racial lines in the

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educational system. Ladson-Billings (1995c) argued that one of the foundations of culturally relevant teaching is to provide access to learning resources that are consistent with the values, beliefs and learning styles of students. It is impossible to summarize all major principles of culturally relevant teaching, so only four are presented in this study to initiate the learning process and its implications. These are: (1) teachers' perception; (2) the importance of culture; (3) curriculum; and (4) instruction. However, mathematics teachers usually see cultural content as irrelevant for their subject.

Nelson and Guerra (2013) suggest that two areas need to be addressed in teacher preparation: teachers' beliefs and cultural knowledge awareness. These areas influence whether new teachers will implement critical pedagogical teaching practices once they enter their classrooms. Nelson and Guerra's (2013) argue that many educators lack cultural knowledge to reference the intercultural dynamics in their classrooms or reinforce the mathematics learning process. In their study of 111 teachers and educational leaders in two school districts, located in Texas and Michigan, educators addressed only the visible elements of culture (food, ceremonies, language, music etc.) and overlooked the less obvious elements, such as beliefs, values, behaviors, attitudes and stereotypical thinking in their instructional practices. In addition, teachers examined their interactions with the student population and viewed the unexpected behaviors in the classroom as problematic and warranting technical solutions.

As a result, they focused on improving the technical aspects of the students' classroom behavior, while ignoring their own stereotypical beliefs and cultural knowledge limitations. The findings from this study revealed that of the 111 educators who participated in the study, only one (>1percent) appeared to be culturally responsive. Eighty (80percent) of the teachers exhibited one or more stereotypical views about diverse students' backgrounds. The (1percent)

that expressed critical pedagogy awareness also demonstrated cultural knowledge specific to students' backgrounds rather than just seeing personality and skill differences. Nelson and Guerra (2013) recommended that a focus on preservice teacher beliefs and cultural knowledge awareness is necessary to reform current classroom teaching practices and improve student learning along culturally responsive initiatives.

As indicated, teachers can have good intentions to engage students, but they must be willing to practice a pedagogy that empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes (Ladson-Billings, 1994). Larke (1990) calls good intentions, "humanitarian non-education." Gay (2000) states:

> However important they are, good intentions and awareness are not enough to bring about the changes needed in educational programs and procedures to prevent academic inequities among diverse students. "Goodwill must be accompanied by pedagogical knowledge and skills as well as the courage to dismantle the status quo. (p. 13)

Therefore, to enact real change, teachers must embrace positive views about underserved students in their instructional approaches. Often, the culture of schooling has historical precedents mandated with good intentions.

Gay (2010) warns that classroom transformation will not occur without the introduction of new and effective pedagogies that enable teachers to enact ways of engaging students in the classroom. Tate (2005) argues that most teaching practices in mathematics do not meet the learning styles of students, especially African American students. He explains how a new teacher used her knowledge of cultural context to help her students solve mathematics problems. Tate describes an "Eating Pie and Learning Fraction" lesson in which he observed an elementary school teacher candidate set a context for a mathematical problem. Her students needed to

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understand fractional parts by using what she thought was a common cultural topic: pumpkin pies. The teacher candidate explained the context as a Thanksgiving holiday favorite—pumpkin pie but, well into her explanation of fractional parts, an African American student was disengaged. When asked about the students' disengagement, the teacher candidate replied, "Oh, he does not like math." Therefore, while the teacher candidate thought she was engaging in culturally relevant teaching because pumpkin pie is a favorite for Thanksgiving holidays, she was only culturally responsive to her White American students. The teacher candidate failed to realize that pumpkin pie was not universally relevant to all students because they have not experienced it. Most African American families are likely to serve sweet potato pie for Thanksgiving dinners instead of pumpkin pie. So, rather than engage in the lesson on fractional parts, the African American student was preoccupied or unintentionally disconnected from the problem-solving lesson. Tate's (2005) example illustrates how even a slight misconception in cultural knowledge has the potential to affect students' learning of mathematics.

Ladson-Billings' (1995a) research suggests that teacher preparation thinks about the school populations that preservice teachers are likely to serve. Ladson-Billings (1995) stressed that teachers must be facilitators in the learning process and assist students in their learning. Ladson-Billings' work (1994, 1997) included conversations about how mathematics marginalizes students academically and culturally and how Culturally Relevant Pedagogy addresses issues of equity. Ladson-Billings (1994) states that the primary aim of culturally relevant pedagogy is to assist in the development of students and allow them to achieve excellence and identify with their culture. In Ladson-Billings' (1994) report, she explained that the knowledge of culturally relevant pedagogy is essential to (1) incorporate students' cultural context to design culturally relevant classroom environments (attitude and high expectation); (2)

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provide students with the knowledge and skills needed to learn mathematics while helping

students maintain their cultural identity (cultural competence); (3) connect students' cultural

experiences (cultural events and familiar examples), and individual learning styles to facilitate

the teaching and learning process (curriculum and instruction); and (4) provide students with

multiple opportunities to learn using a variety of techniques (active learning).

In Ladson-Billings' view, when teachers commit to teaching culturally relevant

mathematics, they look at their own biases and the social obstacles that prevent students from

achieving success. In her presentation at the 2012 annual meeting of the American Educational

Research Association (AERA), on "Equity pedagogy and culturally responsive teaching,

learning, and actions in schools." Ladson-Billings reaffirmed that achievement cannot be

reduced to high test scores in high stakes tests. Not only must teachers encourage academic

success and cultural competence, they must also recognize social inequities and their causes and

help students to understand, and critique current social inequities. Academic achievement is

combined with relevant and transformative learning experiences that help students get involved

in active knowledge construction. Ladson-Billings (1995a) writes about preparing teachers to

teach for equity and social justice. She states:

> All students can be successful in mathematics when their understanding of it is linked to
>
> meaningful cultural referents, and when the instruction assumes that all students are
>
> capable of mastering the subject matter. (p. 141)

Therefore, teachers need to enhance their own cultural knowledge to counter inequality in

classrooms with low achieving students.

Ladson-Billings (2009) provided an example of how mathematics plays a role in

analyzing the issues of inequity that affect students and their communities. The goal of culturally

relevant pedagogy is to increase the cultural knowledge of teachers' of culturally diverse

students (Ladson-Billings,1994). Ladson-Billings' research (1994, 1997, 2009) made numerous

efforts to promote culturally relevant pedagogy aimed toward social justice and equal

opportunities for all students. Ladson-Billings (2009) argues that the teacher preparation process

needs to build the preservice teachers' knowledge of culturally relevant strategies that develop

diversity awareness and provide opportunities for all students to learn mathematics. The concept

of culturally relevant pedagogy is to move beyond the narrow focus of standardized test

performances and to recognize mathematics within the broader cultural context. In Ladson-

Billings' view, another goal is to improve learning by contextualizing it in everyday settings.

Culturally relevant teachers "help students develop knowledge by building bridges and

scaffolding for learning because they believe that knowledge is continuously recreated, recycled,

and shared by both teachers and students" (Ladson-Billings, p. 72, 1994).

A critical feature of culturally relevant teaching is to teach "to and through" personal and

cultural strengths of students (Gay, 2010, p. 26). Gay (2000) explains that caring educators are

(a) genuinely concerned about their students' wellbeing; (b) respectful in how they communicate

their expectations and promote action and accountability; (c) are emotionally warm yet require

high levels of performance from their learners; and (d) are cognizant of the teaching/learning

dynamic and willing to commit to partnering with their students to achieve academic success.

Gay's (2010) observation of culturally responsive teachers showed them to be culturally aware

of the differences in the classroom.

Ladson-Billings' (2009) began investigating what she would later term "culturally

relevant teaching" that centered on talking with, observing, and analyzing the practices of

successful teachers of African American students. By reflecting on her own personal experiences

as an African American female, educator, and researcher, Ladson-Billings' (2009) historical

work with teachers presents valid information to educators along with integrated knowledge that

values equal opportunity access to mathematics. The background of her research came from her

attempts to link student experiences at home to their experiences in the classroom. Her research

intent was to identify and record the instructional practices of successful teachers who used

culturally relevant pedagogy. So, she conducted a three-year study that observed the approaches

of experienced and successful teachers of African American students in a mathematics research

project called "Effective Mathematics Instruction" to look for common beliefs and practices

among these teachers.

In Ladson-Billings (1995a) research, eight teachers were selected by African American

parents who believed them to be exceptional based on the enthusiasm that their children showed

in learning in their classrooms, the consistent level of respect they received from the teachers,

and the perceptions that these teachers understood their needs at home and in mainstream

communities. The selected participants were interviewed, attended focus group meetings, and

were observed through videotapes in their classrooms. After working with these teachers,

Ladson-Billings discovered three beliefs that formed the basis for what she termed culturally

relevant pedagogy (Ladson-Billings, 1994, 1995a, 1995b). The foundation of her framework of

culturally relevant pedagogy was to offer pertinent information to educators as a practical model

for improving teacher practice. These three beliefs are:

(1) "students must experience academic success"; (2) "develop and/or maintain cultural

competence"; and (3

(2)) "develop a critical consciousness through which they challenge the status quo of the

current social order" (Ladson-Billings, 1995a, p. 160).

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Academic Success

Students must "experience academic success" (Ladson-Billings, 1995a, p.160). This means that teachers should hold high expectations of all students and believe they can achieve academic success.

In her research and observations, students expected teachers to hold high expectations for learning, offer positive reinforcements, acknowledge their accomplishments and take interests in their lives inside and outside of the classroom. In turn, teachers set clear goals for themselves and student's performances, communicated high expectations to students, and drew on students' background knowledge to support their learning (Ladson-Billings 1995b). Overall, teachers were aware of individual student interests, concerns, and experiences and tied these factors into their teaching. They demonstrated awareness of the damages caused by negative stereotypes and they purposefully used the knowledge from their own backgrounds to verbalize high expectations for students. The research found that these teachers were successful with African American students because they believed that these students could succeed and set high goals for them. Teachers went beyond the classroom to attend church and sports events in the community. They challenged students to work hard and encouraged them to learn collaboratively and be responsible for each other's learning. Students who were furthest behind received individual attention and encouragement. Therefore, to teach a culturally relevant algebra lesson effectively, preservice teachers must reflect on their beliefs about themselves, their students, and provide instructional support in such a way that students and teachers will experience success.

Cultural Competence

Students must "develop and/or maintain cultural competence" (Ladson-Billings, 1995a, p. 160). This means that teachers should understand their students and establish positive personal connections to their lived experiences.

Cultural competence is gained through cultural knowledge that allows students to maintain cultural integrity while seeking academic excellence. According to (Ladson-Billings, 1995b), culturally relevant teachers organized the curriculum around "broader ideas". Teachers did not rely solely on the state curriculum's textbooks to decide what to teach; they introduced alternative interpretations of the curriculum. These teachers drew on students' knowledge and backgrounds to modify the content and support students in their learning development (Ladson-Billings, 1995b). Student experiences were not pushed aside, hidden, or ignored for the sake of academic success. They presented students with multiple instructional approaches and helped them to differentiate what was relevant and factual from what was irrelevant. They made sure that the content of the standard textbook curriculum was open to critical analysis and clarified misconceptions that students may have. They demonstrated that they were not the only sources of knowledge in the classroom. Students and teachers shared the responsibility of restructuring knowledge and teachers facilitated the dialogue to investigate and re-construct the curriculum. In a culturally relevant teaching environment, the teacher assumes the role of a "facilitator" who guides students. Teachers functioning as "facilitators" believe that students are capable of learning and ensure that students achieve success. Therefore, to teach culturally relevant algebra lessons, preservice teachers must find ways to connect students' learning back to their community by providing them with real-world examples.

Critical Consciousness

Students must "develop critical consciousness through which they challenge the status quo of the current social order" (Ladson-Billings, 1995a, p. 160). This means that teachers should engage students in specific relevant mathematics content situated in familiar contexts to facilitate active construction of their understanding.

Ladson-Billings (1995b) argued that "not only must teachers encourage academic success and cultural competence they must help students to recognize, understand, and critique current social inequalities" (p. 479). She observed that effective teachers of African American students saw their role as agents and were aware of their position in the classroom and how they influenced their students' classroom behavior. They insisted that students move away from the false dichotomy of rigidly right and wrong answers to questioning the classroom and community actions. Mathematics teaching that emphasizes repetition; drill; right-answer and wrong-answer rarely challenges students to think beyond the classroom and investigate their lived-experiences. This requires that teacher candidates acquire cultural knowledge, skills, and professional disposition to identify, revise and be highly reflective about their teaching practices. Therefore, to teach algebra lessons effectively, preservice teachers must develop knowledge of social justice so that they and their students challenge the status quo of the current social order.

Although Ladson-Billings' initial work (1994, 2000, 2001) on the framework of culturally relevant pedagogy did not focus specifically on promoting mathematical teaching, its focus on the characteristics of successful teachers of African American students and their roles in content application are valuable for all teaching. Effective teachers know how to make lessons relevant by assisting students to make connections to previous learning experiences (Ladson-Billings, 1995a, 1995b). Equity pedagogy involves having preservice teachers use constructivist

pedagogical approaches to incorporate students' prior lives and cultural experiences with teaching content and skills in mathematics. Although equity is the first of six National Council of Teachers of Mathematics' (NCTM, 2000) principles, this principle calls for teachers to set and maintain "high expectations and strong support for all students" (p. 12), by embracing and incorporating their diverse backgrounds into the mathematics classroom. However, the way teachers are prepared to implement these recommendations requires constant examination as the classroom demographics and technology evolve.

The right side of the framework of culturally relevant pedagogy refers to critical pedagogy. Critical pedagogy is defined as the "opportunities that all children have to benefit from classroom instruction" (Ladson-Billings, 1995b, p. 130). Critical pedagogues argue that the teachers' perceptions are of central importance, so they need guidance when translating their perceptions into practices. Critical pedagogy can be viewed in many ways - one is how individuals look to the common good by self-reflection and another is a focus on the needs of others from different cultural groups for fairness and equity. The concept of critical pedagogy extends from mathematics learning to fairness and equity in teaching that PSTs must acquire beyond mathematics textbooks and standards. Like culturally relevant teaching, critical pedagogy broadens the teachers' concept of pedagogy to include personal responsibilities and interpersonal relationships. Therefore, students and teachers engage in exploring, critiquing, analyzing, and reflecting on real-world issues. Students and teachers analyze social inequities in classrooms that affect students' lives and their communities. It is the knowledge that goes beyond mathematics to include social contexts and teaching practices that create these inequities. However, critical pedagogy is difficult for educators to implement because they must be shown how to modify mathematics content that reflects the realities of different groups of students.

Algebra matters. The typical seventh to ninth grade algebra courses are considered the "gatekeepers" to gaining access to higher education and future employment (Moses & Cobb, 2001). Mastering algebra is a fundamental step to preparing for higher level mathematics courses in high school. Furthermore, limited research has focused on middle school student success in algebra. Students who struggle with mathematics in middle school have a lower chance of meeting eligibility requirements in high school and public universities. A strong foundation in algebra in middle school is the key to higher education access. Evidence over many years suggests that success in middle school math is a key determinant of students' success in high school and beyond (Moses, et al., 2009). Mastery of algebra is a critical step to enrollment and success in college preparatory mathematics.

In mathematics, algebra is the "gatekeeper" because it allows people access to higher education, career opportunities, and the power to transform their lives (Ladson-Billings, 1997). Therefore, algebra teaching should provide all students with the opportunities to gain access to pass through the "gate". Moses and his colleagues contend that algebra is the entry point and serves as a curricular gatekeeper to advanced mathematics enrollment, higher education, and economic opportunities. Mathematical thinking improves students' ability to encode and decode information in other areas of study. According to Moses et al., (2009), students that are very privileged can do without mathematics, but, for many underserved students, mathematics is the key for their life chances of college major and career choices. However, many underserved students are prepared to be outside of many career choices and workforce advancement. Algebra stratifies underserved students out of many inside and outside school opportunities partly because traditional teaching does not make meaningful connections to help students pass through the "gatekeeper" and reach advanced mathematics (Moses & Cobb, 2001).

In 1990, Bob Moses, a civil rights activist and mathematician, found that many students he worked with did not understand how mathematical symbols and operational signs were constructed and applied to everyday life. Many of these underserved students had difficulty learning mathematics including his children. In response, Moses founded the "The Algebra Project" to give students equal access to advanced mathematics. The project was initiated at King Elementary school in Cambridge, Massachusetts due to concerns for the few mathematics learning opportunities for those children who were performing in the lowest levels. The aim was to improve participation and performances in middle school algebra and enroll underserved students in high level mathematics classes in high school.

The idea that Moses drew on for the Algebra Project is that students first need to understand mathematics through everyday language before they can translate that into the more abstract language of mathematics. For example, before introducing students to the concept of a number line, Moses' teachers first introduced students to a train line with many stops between its beginning and its destination. Using a "curricular intervention" called the Transition Curriculum, the structure of an urban transit system was used to direct positive and negative numbers based on students' lived experiences. Students knew how to use the transit system and map their travels to guide them. Students' commute experiences were built into the concepts of the number line, positive and negative integers, and distance measurements (Moses & Cobb, 2001). The goal was to enable seventh and eighth grade students to take advanced algebra in middle school to prepare for higher-level mathematics classes in high school. First, students communicated their transportation experiences in their own preferred styles and through multiple presentations: talking, writing, videos, pictures, and drawing. The Algebra Project transformed the curriculum and instruction in a five-step process. Therefore, students:

(1)   Engaged in a "to do" everyday transition experiences.

(2)   Drew on a visual representation of their experiences.

(3)   Communicated their experiences in their own language and learning style.

(4)   Discussed features of interest from their experience.

(5)   Described mathematics symbols to represent their experiences. (Moses & Cobb, 2001)

The findings show that, because of the connection of activities with real life, the transition curriculum material was meaningful and relevant to students. First, they had hands-on activities that transformed into mathematics expressions and symbol discussions as they gained additional knowledge in mathematics. About 40 percent of King's 1998 graduates passed their school algebra exam and state-mandated tests for the first time. In middle schools where majority of students participated in the project, graduates enrolled in and passed high school college preparatory mathematics courses at twice the rate of their peers from the non-Algebra project. The original group of students advanced either to the college preparatory mathematics courses or to honors algebra or geometry classes (Moses, et al., 2009). In addition, students maintained their cultural identities and were affirmed (Moses & Cobb, 2001; Moses et al., 2009).

Gay (2000) asserts that learning does not begin from knowing nothing. Students arrive in the classroom with misconceptions that impede their learning process and as such create their own learning based on their limited preexisting knowledge. Gay (2000) affirms that, a pedagogical paradigm needed for various ethnic groups—should "make classroom instruction more consistent with the cultural orientations of ethnically diverse students" (p. 29). The instructional process must "dismantle the status quo" (Gay, 2010, p. 14) and contextualize mathematics issues in a cultural perspective that encourages students to engage in learning. This

requires that mathematics concepts be linked to the global environment and provide all students with the equal opportunities to improve their learning (Gay, 2010). Students learn better when ''they are taught through their own cultural and experiential filters'' (Gay 2002, p. 106).

High expectation. According to Gay (2013), there are factors that reinforce many teachers' claims about teaching culturally responsive topics: (1) teacher candidates may accept the overall framework of CRP approaches in mathematics but remain unfamiliar with the practical applications. (2) teacher candidates are uncertain about engaging students' culture in the curriculum, so they reject students' cultural realities in their classrooms, (3) teacher candidates may take a stand for cultural blindness by ignoring the existence of cultural differences, and (4) teacher candidates may continue to maintain biases, even after training in cultural awareness.

Teacher attitudes and expectations about students who differ from them culturally and socially is fundamental because they intertwine with the behavioral expressions of knowledge, beliefs, and values that teachers hold in providing quality learning opportunities for these students (Gay, 2010). Gay (2010) asserts that culturally responsive teaching begins with teachers setting high expectation for all students to learn at higher levels. For culturally relevant teaching to be realized, classroom participation must involve listening to others and having a positive attitude and expectation of them. In contrast, diluting the curriculum or lowering expectations of students poses problems for learning at higher levels. Culturally responsive teachers set high expectations for learning and draw on their experiences, knowledge, and backgrounds (Ladson-Billings 1995b). Ladson-Billings (1994) maintains that culturally responsive teachers must:

1. Have high self-esteem and high regards for others.

2. Believe in discovering the knowledge within students.

3. Make connections between mathematics and students' culture.

4. Help students see themselves as part of their culture and mainstream community.

She added that teachers must reflect on their own perceptions of students and be honest about why expectations are lowered for some students more than for others in learning situations. Further, she explained that low expectations of students are based on teachers' perceptions about students' home environments and unfounded assumptions about students' intellectual abilities. Unfortunately, when students notice that teachers expect high or low of them, they equate this to the teacher's care for them.

Relevant context. Gay (2010) asserts that a culturally relevant curriculum must be validated to:

1. Acknowledge the cultural differences in learning styles.

2. Build meaningful connections between mathematics content and the lived realities of students.

3. Help students to value their own and others' cultural traditions.

4. Include a variety of resources to connect students to the mathematics taught in the classroom. (29)

Teachers need to consider the relevance of the topic to learners when making instructional decisions (Darling-Hammond & Bransford, 2005). Gay (2010) explains,

the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students makes learning encounters more relevant and effective for them. (p. 31)

Curriculum sources and content that provide accurate presentations of cultural diversity offer benefits for improving student achievement. The knowledge in the form of "culturally relevant curriculum content should be chosen and delivered in ways that are meaningful to the

students for whom it is intended" (Gay, 2010, p. 128).Therefore, teachers must engage students in relevant learning by presenting information that is personally linked to them (Gay, 2010). Teachers should ensure that culturally relevant content is accurate to "fill knowledge voids and current existing distortions" (Gay, 2010, p. 169). Teacher candidates need to understand that even when lessons contain cultural content, it must be meaningful to specific issues in the students' communities. The mathematics curriculum that is taught in public schools; "emphasizes repetition, drill, and convergent thinking" (Ladson-Billings, 1997, p. 699). Both teachers and students need to be exposed to a variety of content that is formal or informal and encompasses what is delivered in the "societal curricula" (Gay, 2010, p. 171). However, underserved students have less access to opportunities are necessary to develop mathematical knowledge that is meaningful and relevant to their lives (Gay, 2010). Students must structure their own learning and control their own academic success (p.172).

Multiple representation. No single content source offers a curriculum that is more challenging to students and moves them towards higher advancements in mathematics skills. Gay calls for diverse sources on curriculum content, both within and outside of school, to be revised and made inclusive of various cultures in the classroom. Gay (2010) recommends that content consist of multiple representations, such as equations, graphics, tables, pictures, and word problems. She adds that:

> Content about the histories, heritages, contributions, perspectives, and experiences of different ethnic groups and individuals, taught in diverse ways, is essential to culturally responsive teaching. (p. 127).

Gay (2000) asks teachers to stop using "traditional instruction conventions" (p. 27) and modify the curriculum to reflect the cultural styles of students that enhance their learning opportunities.

When mathematics is taught in multiple contexts, learners are more likely to extract the relevant features of the concepts. This process is what Gay (2010) has called "culturally validating and affirming" and what Ladson-Billings calls "maintaining cultural competence" because, "it builds bridges of meaningfulness between home and school experiences as well as between academic abstractions and lived sociocultural realities" (Gay, 2010, p. 31).Furthermore, the textbooks' curriculum does not include the experiences of students from culturally diverse or low-income communities and has little connection to these students' lives.

The traditional curriculum is narrowly focused on the technical aspects of mathematics thereby, ignoring many cultural contributions. Although, mathematics textbooks are filled with facts that assess students' abilities; the textbook content structure does not connect these facts to their real-life problems. In fact, textbook content makes it difficult to enact culturally responsive teaching because of the distorted perceptions about underrepresented students (Gay, 2010). This creates constraints for teachers to engage students in active teaching practices. Teachers and students need to conduct their own analyses of textbooks and other sources of information and to reconstruct the existing curricula that have marginalized certain student populations. Teachers and students can be active participants in contesting, correcting, supplementing, and improving textbook and media content for higher quality curriculum content. A variety of curricula resources, such as textbook content, electronic resources, multimedia, and visual content need to be examined (Gay, 2010). Teachers need to identify and supplement textbook topics to make it relevant to students and engage them in instructional reasoning. A culturally responsive teacher that teaches mathematics is culturally aware and ethically informed (Gay, 2009).

Challenges in Teacher Preparation

Reflecting on her observations for the day, Ladson-Billings (2009) asked herself: Is it

reasonable to expect preservice teachers to be expert managers and pedagogues in diverse

classroom settings when even experienced teachers are struggling with these students?

How can we expect newly minted teachers to find success in such classrooms? (p.1)

Many teachers are underprepared for their teaching in schools serving underserved students of

color and students living in poverty (Darling-Hammond, 2010). Research analysis shows that the

demand for new teachers has increased due to increases in diverse student enrollment.

Specifically, mathematics teacher shortages vary by location and student population and requires

specific preparation to address the unique needs of each context.

There is evidence to show that novice secondary mathematics teachers do not feel

prepared to teach diverse populations. One possible reason is that teacher education programs

separate the teaching of diversity issues from other parts of teacher education (Hollins &

Guzman, 2005). Findings from the Hollins and Guzman (2005) review revealed major barriers

for preservice teachers' implementation of equity pedagogy, including inflexibility in thinking,

limited experiences, and lack of socialization with diverse students. In addition, findings from

studies by Hollins and Guzman indicated the challenges of preservice teachers in integrating

cultural knowledge during their practice because of how preservice teachers understand subject

matter. This concurs with Sleeter's (2008) observation that "the power of prior socialization and

on-going everyday life experiences of White people" (p. 567) poses a significant challenge for

White preservice teachers to recognize and change patterns of racism. Specifically, in teacher

education, Hollins and Guzman (2005) found 101 studies between 1980 and 2002 that involve

preparing teachers to teach diverse populations. They found that candidates generally lacked

confidence to do well in diverse settings and preferred not to be placed in situations where they felt uncomfortable.

Another key finding in Hollins and Guzman's (2005) study was that teacher education programs often separate diversity from content-specific pedagogy. Not only are diversity courses separate, but the courses in multicultural education challenge PSTs' beliefs about diverse populations rather than help them learn how to teach diverse populations. Villegas and Lucas (2002) encouraged teacher educators to interweave prospective teachers' coursework, learning experiences and teaching strategies that research has shown to prepare preservice teachers for working successfully with diverse students. For the past few decades, teacher education has often been modeled on university instructors who teach theory and then send PSTs into the teaching to practice the theory they have learned. Research in teacher preparation revealed that PSTs are often provided with many opportunities in their coursework to investigate, prepare, and reflect on elements in their practice of teaching (Campbell & Dunleavy, 2016). Yet the interactive elements of teaching are often left to teaching practices (Grossman, et al., 2009). Therefore, teacher preparation occurs in two distinct contexts, university and teaching, and PSTs are often left to make connections between these two contexts on their own. Thus, in traditional teaching practices, the university instructor is often unaware of the teaching practices that occur in teaching practice and unable to mediate what PSTs are learning.

To overcome this "pitfall", teacher educators must help PSTs realize the link between theory and practice. To successfully combine theory and practice, concurrent enrollment in the university course work and teaching work is crucial. What is missing from literature is a concrete explanation of culturally relevant curriculum guidelines and instructional techniques. Sleeter (2001) suggested that what PSTs believe is an equitable environment and strategies that support

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them in their emerging practices. These studies highlight the need to consider strategies that aid

PSTs in creating equitable environments. Although experiential learning has the potential to

contribute to PSTs' learning, the alignment of school-based teaching practice and university

courses is crucial.

According to Zeichner (2010), establishing a relationship between coursework and

teaching-practice is a significant response to the problem. Zeichner (2010) elaborates on a hybrid

space to understand the gap between university and school-based contexts by asserting that

"individuals draw on multiple discourses to make sense of the world" (p. 92). The goal of hybrid

space is to bring university-based and school-based teacher educators together to improve

teacher educator experiences in a non-hierarchical manner. Zeichner (2010) cited national studies

on teacher education that demonstrate the detrimental effects of disconnecting teaching practices

and show "carefully constructed teaching practices that are coordinated with campus courses" (p.

484), which are more influential in PSTs learning than traditionally separate teaching practice.

Therefore, the overemphasis on academic course work is disconnected from the realities of the

classrooms and communities that teachers are being prepared to enter. If teachers are prepared to

meet the needs of underserved students, teacher educators need to better connect PSTs'

university and school experiences (Zeichner, 2010). Other studies have shown the quality of a

teaching practice to have positive effects on teacher candidate outcomes, such as perceived

competence; however, the duration of teaching practices has no significant effect (Caprano et al.,

2010). So, rather than recommend more time in teaching practice, some studies advocate

addressing the structures and activities that constitute quality teaching practices.

Some scholars have argued for a cultural dimension and an increase in culturally

sensitive learning environments (Ladson-Billings, 2001; Larke, 1990). However, preparing

culturally responsive teachers require (1) transforming PSTs' diversity attitudes; (2) increasing their cultural knowledge, and (3) equipping them with the skills needed to effectively teach the increasing diverse students (Gay, 2010). Many preservice teachers arrive in their teacher preparation program hoping to gain practical knowledge to connect directly to their daily routines and teaching responsibilities. They want to find "best practices" (Gay, 2013, p.63) that are universal for all students in a classroom setting. While these expectations are understandable, they are impossible because the right solutions are not always present in the moment when teaching occurs. Part of the challenge is ensuring that all students have access to algebra which means that quality teachers are prepared who know and can teach the subject. The teachers' role is to make sure that every one of their students learns. There is no shortage of teachers who want their students to learn, but we are not equipping them. "It's like sending people out into a very difficult environment with almost no skills or tools to do it" (Hall, 2009, p.5).

Another major challenge is that most teachers lack experiences in confronting cultural diversity issues that fail to meet their expectations when working with diverse students. Unfortunately, often the poorest performing students are from racial, ethnic, low-income or cultural groups that differ from the teacher. Sleeter (2001) noted that, while many White preservice teachers expect to work with children from a variety of cultural backgrounds, they have little cultural knowledge or experience with sociocultural issues that affect these students in learning. Sleeter (2001) asserts that teacher preparation has failed to build the teachers' cultural knowledge and understanding of culturally diverse students. Although, majority of research has examined how to help young White preservice teachers to develop awareness, insights, and skills for effective teaching in multicultural contexts, the preservice teacher's ability to navigate

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multiple cultural views is hampered. They have limited success because of the narrow opportunities available for them to confront real-life issues with students in diverse classrooms.

Furthermore, teacher preparation programs that confront various issues of teacher identity, perceptions, and attitudes are uncommon (Reiter & Davis, 2011). The context of experience-based education represents a shift from what teachers know and believe to what teachers do (Grossman, et al., 2009) is also important. Grossman, et al., (2009) proposed that the teaching of teacher education develops "Pedagogies of Enactment" that provide PSTs with the opportunity to practice culturally relevant teaching within their university method courses. Some teacher preparation programs are designed for "urban" education, the significance of diverse cultures is rarely a feature of such programs (Ladson-Billings, 1995a). Kulm et al., (2016) argues that placing preservice teachers at the center of teacher preparation has the potential to support their progress toward current standard-reform strategies and cultural knowledge. However, the traditional teacher preparation model of the one-sided, isolated, cultural coursework and teaching practice limits the teacher candidates' abilities to engage in teaching students. Teaching practices may occur in diverse settings, but these settings are difficult for "real" teaching because they are situated in middle-income and suburban schools (Ladson-Billings, 2000). By not spending time in urban public schools, the teacher candidates' perceptions and attitudes towards teaching diverse students are not challenged.

Teacher preparation must shift from practice based to experience based (Brown et al., 2011). The focus is to create a teacher preparation context in which coursework and teaching practice interact to support the skills of future teachers. However, many underserved students continue to struggle in mathematics, limiting their preparation for better careers (Brown, et al., 2011). By incorporating student experiences into classroom practices, teachers: (1) affirm

students' interests and provide meaningful reinforcements; (2) empower students to have access to mathematics knowledge; and (3) utilize students' cultural knowledge. Overall, preservice teachers need to develop an understanding of underserved students before they notice "teachable moments" in classroom settings. It begins with teachers recognizing that the changes that need to be made are her responsibilities, not a problem with her students (Moses et al., 2009).

Studies about culturally responsive teaching, conducted over the course of the past 30 to 40 years, have provided evidence on innovative practices that are developed by Geneva Gay and Gloria Ladson-Billings. These "teachers of teachers" develop instructional delivery based on their research about culturally diverse students. They recommend training in instructional techniques that match the diverse learning styles of diverse students. Gay (2002) emphasizes that educational programs improve on preparing preservice teachers with culturally responsive knowledge, attitudes, and skills that improve the success of diverse students. Through proper training, preservice teachers learn to bridge the gap between instructional delivery and diverse learning styles and to establish continuity between how diverse students learn and how they communicate. Sleeter (2008) found that teaching practices with minimal engagement in actual classroom teaching is not enough to expose prospective teachers to the cultural connections that they need to work with students in diverse classroom settings. Such programs fail to change most preservice teachers' beliefs about underrepresented students and work to reinforce existing stereotypes. Also, evidence shows that minimal engagement does not provide a broad knowledge awareness to challenge the negative cultural values that are embedded in education institutions.

In addition, several studies have documented the impact of student-teacher racial mismatch on the learning experiences of Black children (Gay, 2000). Ladson-Billings (1995) suggested that community teachers are a part of the neighborhood they serve and engage their

students to make "connections between their local, national, racial, cultural, and global identities" (p. 25). Gay (2000) argued that teachers develop culturally relevant pedagogy that transforms the next generation with cultural and historical knowledge. Teachers with culturally relevant curriculum knowledge can use instructional approaches and provide practices that connect with their students' identities to foster self-esteem and student understanding in urban schools.

Beliefs of Two Different Teachers

According to Gay (2010), teachers who are culturally responsive provide students with positive and relevant examples from their lived experiences and teach within their own "cultural frames of reference" (p. 26) and "to and through the strengths of these students" (p. 31). Another reason that set these teachers apart from those that Gay termed "assimilationist" is their desire to support students in thinking critically about topics and learning beyond the classroom to make changes in their lives and communities. Gay (2010) noted that the role of teachers is to arrange for learning experiences that keep students engaged while preparing them for future instruction. Table 1 below illustrates how these two teachers (the Assimilationist and the Culturally Responsive Teacher differ in their goals, perceptions, and attitudes towards instructional approaches. For example, the Assimilationist teacher overlooks the tenets of culturally relevant pedagogy with claims of lowering the curriculum to benefits "all" students.

	Assimilationist Teacher	Culturally Responsive Teacher
Goal	Sets goal to teach students basic algebra knowledge to conform with standards.	The goal is to teach algebra knowledge and develop students' critical thinking skills, so they can participate in their communities' progress.
Perception	Not responsible for helping each student. Beliefs she can only do so much. Does not reflect on her actions.	Expect high of her students. Beliefs all students are capable of learning at high levels if they are provided access to learning opportunities.
Curriculum	Her curriculum is organized around conventional knowledge. Uses the narrow perspective of the textbook as a guide.	Supplements the standard curriculum to connect students to mathematics and their communities. Incorporates a wide variety of content from students' life experiences and cultural.
Instruction	Instruction is teacher centered; passive and technical.	Uses a variety of active learning techniques, demonstrations, hands-on activities, open communication, interaction, and discussion.

Table 1: The Assimilationist and the Culturally Responsive Teacher

In summary, the Assimilationist is a teacher who believes in the status quo of teaching for conformity. She believes that mathematics knowledge is culture free and the standard curriculum is appropriate for all students. Her responsibility is to communicate the accepted content and ensure that students fit into the existing social system to pass standard tests. On the contrary, the Culturally Responsive Teacher believes in empowering students to think critically about social and community issues and work towards change. She perceives the student's background as an asset to integrate into the curriculum. She understands the differences that students bring to the classroom in terms of background, motivation, and works to build bridges that support students as they learn the curriculum.

Technology-Enhanced Teaching

Schrum et al., (2007) argue that educational technology research has not influenced student achievement and fails to specify instructional approaches that make it easier to understand implications of instructional outcomes. Schrum et al., (2007) suggest that research in pedagogical aspects of educational technology should focus on content-specific learning objectives, the relationships among specific technologies, pedagogical approaches, and teacher preparation methods that make a difference in student learning. Further, Ronau's et al., (2008) state that technologies provide "multiple and varied" experiences but suggest more flexibility in research design and data sources that address concerns in the classroom. Ronau's et al., (2008) assessment of educational technology indicates that some of the software used in the classrooms involve computational exercises, which is like traditional-based teaching methods and rely on single response answers that inadequately confirm students' understanding of concepts. Therefore, this approach limits students' abilities to communicate their process of knowing and keeps teachers from having to monitor student's actual understanding. When students are unable

to communicate the steps taken to solve problems, their test scores are lower or reflect poor achievement levels that may not be accurate.

Further, Ronau et al., (2008) acknowledge that educational technology challenges are more than the inclusion of "digital tools" (p. 17) in teacher preparation. The process must include teachers' mathematical understanding of whether classroom instructions support students' learning and interaction. For example, technology-enriched videos are common strategies to prepare PSTs for practicum experiences and discussions about classroom practices. However, teaching videos are limited in providing interactions within diverse cultural classroom settings. The non-interactive environments of linear videotapes are ineffective at creating contexts that allow teachers to explore and reexamine culture, both individually and collaboratively. The static nature of videos limits active engagement and lacks the sense of a "lived-experience" that SL, a popular, online 3D Virtual Worlds provides (Davis, 2012).

Virtual Worlds Technology

Unlike other technologies, Virtual Worlds technology promotes an interactive two-way communication in the classroom that integrates synchronous (live) with asynchronous (such as video) communication. Teachers use this tool to explore resources, engage students, conduct collaborative inquiry, and resolve real-world problems. Virtual environments connect teachers to global communities with expert instructors, community leaders, and other interested groups. In virtual world environments, visual-based materials, animations, images, streaming videos, and interactive activities are useful in designing lessons that enable teachers to participate in pedagogical practices which mimic real-world classrooms (Roussou, 2009).

In a mixed-method evaluation, Mayrath et al., (2010) investigated both the teachers' and students' reactions to a course content design in Second Life with regards to relevance,

effectiveness, and easiness to learn. Their findings revealed that participants reacted differently to activities that required the development of teaching lessons. First, participants indicated that the activity was not relevant to their course (an undergraduate English course). However, when a second activity was introduced that aimed at role-play, participants found it relevant to explore by taking on the persona of specific role models. Mayrath et al., (2010) concluded that SL activities need to be within the context of PSTs' interests, to enable them to understand the rationale of designing relevant lessons for their own virtual simulation and use. Then, PSTs can create lessons in multiple forms of media and incorporate problem-solving approaches for mathematics simulations (Mayrath et al., 2010). But they need to visualize the relationship between pedagogical lesson designs and teachers' practices to reflect on the use of SL technology to create more learning opportunities ahead.

In another example, Dueñas (2009) studied the social construction of the nature of mathematics engagement in teaching and learning conducted with middle school PSTs. Dueñas (2009) found that the transition from physical classroom to Virtual Worlds was not easy or beneficial to participants because virtual reality limited the PSTs' experiences with digital objects. The vast number of classroom computers were lacking traditional devices, such as the mouse, so moving from one virtual device to another was not the same as moving from one real world device to the next. Participants explained that in the physical world actions are obvious and intuitive to their experiences, but in the VW environment, simple tasks hinder engagement with teaching and learning.

As a multi-user virtual tool, an online computer-generated environment or open-ended space helps teacher and student avatars to interact in various ways that include text and voice technologies that imitate real life situations. Second Life assists in simulation and role-play to

address the limitations of traditional teacher preparation and provide virtual learning through communication, experiences, scaffolding, and professional development. The design of the 3D virtual simulation provides the potential to engage students in specific educational experiences that make teaching and learning accessible, active, and transformative (Cunningham & Harrison, 2010). It can transform the classroom culture, the roles of the teachers, and their expectations of students (Cunningham & Harrison, 2010). Particularly, the Second Life Virtual Simulation Virtual Classroom (SVC) environment enables teachers and students to engage in developing and constructing new knowledge (Blake & Moseley, 2010). Thus, the Second Life environment offers interactive and explorative opportunities for preservice teacher and student avatars to engage in mathematics teaching and learning through real-world simulations. However, there are concerns about how SL uses avatars to facilitate teaching and learning in a virtual classroom setting, which are yet to be fully studied (Hew & Cheung, 2010).

Simulation provides engaging opportunities for preservice teachers to transfer skills from coursework to teaching practice and to a real classroom setting (Mirliss et al., 2012). Further, simulation enables teachers to build unique lessons, deliver instructions in a virtual classroom and create new educational experiences for themselves and their students (Mirliss 2014). By assuming new identities, as avatars, and imitating reality in virtual environments through role-play, users can transfer knowledge and perceive learning through simulations that are viewed as real (Mirliss et al., 2012). In summary, simulations are computer-assisted learning processes that transcend face-to-face scenarios and allow users to be transported to various computer-generated locations (Mirliss et al., 2012). Preservice teachers are exposed to better opportunities for creating classroom lessons that focus on students' knowledge and misconceptions (Mirliss 2014).

In this example, Gregory et al. (2011) designed virtual PREX simulation environments to engage preservice teachers in teaching practices that test their cultural knowledge, professional skills, and confidence in teaching before they enter real-life classrooms. Initially, the authors did not incorporate voice communication into the Virtual PREX design. As a result, preservice teachers reported that their virtual teaching practice did not prepare them for their teaching roles (Gregory et al. 2011). However, a preceding study designed by Gregory and Masters (2012) incorporated simulation, role-play, and voice communication for preservice teacher practices that were equivalent to face-to-face engagement. Gregory and Masters (2012) concluded that flexible voice communication in Virtual PREX allowed teachers to engage in experiences with students that were of interest and valuable to them.

Simulation was used in the KATE Project to act out the experiences of teaching 6th to 8th grade algebra classrooms that were focused on underserved students who had different learning characteristics and personalities. The KATE Project was a simulation practice in which one preservice teacher assumed the role of an actual teacher and interacted with avatar students who responded to the tasks assigned. There were complex interactions in the virtual classroom setting for the students to exhibit emotional conditions that tied to their diverse personalities and learning preferences. Thus, the success of the teaching relied on the choices made by preservice teachers who experienced working with culturally diverse learners.

Knowledge for Algebra Teaching for Equity

Entitled "Knowledge for Algebra Teaching for Equity," (KATE) was a teacher preparation research study that addressed the issues of equity in preservice teacher education. In the program, coursework and teaching practice were combined in a virtual classroom at Glasscock Island where preservice teachers engaged with student avatars. Rather than send PSTs

to receive their practical experiences elsewhere, the KATE research project engaged them in simulation and role-play in SL to acquire practical experiences. The experiential-based framework of a classroom simulation contributes to the much-needed classroom experiences in teaching and learning. Working alongside university instructors who were engaged in situation-specific mathematics instruction, preservice teachers integrated mathematics and culturally specific topics into their instructional practices. Rather than add cultural content to the algebra course curriculum, the KATE Project restructured the mathematics content to connect with cultural knowledge.

The university is the ideal location for PSTs to shift their frame of reference because it is "located squarely between teachers' experiences as students in classrooms and their future experiences as teachers in classrooms" (Kennedy, 1999). Within the context of university practice, preservice teachers investigate specific aspects of teaching under the support of university instructors who incorporate coursework and teaching-work experiences into instructional practices. If teacher preparation programs cannot alter preservice teachers' frame of reference, their past experiences make unfamiliar practices difficult to enact (Kennedy, 1999). Overall, the goal of the KATE coursework was to develop cultural knowledge and problem-solving skills for underserved students in middle schools by applying teaching practice within a university environment. Thus, the KATE Project SVC setting allowed preservice teachers to develop personal avatars to role-play with diverse middle grade students for their teaching.

Preservice teachers upload objects into their teaching plans, insert web links, display content, and connect to multiple virtual displays, such as PowerPoint, images, the Smart Board, and virtual slide viewer. The introduction of SL in the KATE teacher preparation program provides the opportunity for PSTs to experience culturally relevant lesson planning and teaching

practices through virtual classroom simulation (Brown et al., 2011). As PSTs use simulation and role-play, their own learning improves because opportunities in SL include rich multimedia experiences for communicating ideas to students. According to Cheong (2010), the SL environment has advantage over face-to-face classrooms in providing PSTs the opportunities to improve their teaching capabilities without having an impact on "real" students. For example, preservice teachers in a teacher preparation program in SL could embed Web resources to build virtual objects and set specific instructional goals, which is not possible in a face-to-face teaching-practice classroom.

Coursework Design. Anderson (2013) argues that the transformative learning experiences have prepared PSTs to teach the increasingly diverse student populations in public schools. Their focus was on engaging PSTs in mathematics practices and communication to create equal opportunities for underserved students to learn advanced algebra (Anderson, 2013). Thus, the KATE Integrated Mathematics and Science (MASC) algebra method course was initiated through a Simulated Virtual Classroom (SVC) to develop teacher candidates' cultural knowledge and skills in a contextualized environment rather than as an isolated subject. The primary focus was for PSTs to acquire cultural knowledge and skills within the context of the SVC environment in three fundamental ways: (1) integrate culturally relevant topics and algebra content to enhance learning; (2) create curricula based on real-life examples; and (3) connect instruction to students' experiences.

Prototype curriculum. To expand preservice teachers' cultural knowledge, the algebra course engaged them in planning algebra lessons that customized standard mathematics curricula to encourage their participation and interest in learning. Teacher candidates experienced how culturally relevant algebra lessons are adapted for teaching students who are historically

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underserved in mathematics learning. Each candidate created a prototype lesson plan that addressed issues of equity (culturally relevant teaching, situated learning, critical pedagogy, socioeconomics etc.) for underserved students. The lesson plan was designed to incorporate diverse students' knowledge into algebra content for middle-grade public school classrooms with underserved students. Further, ideas about cultural content and algebra learning were seamlessly integrated into lesson plans to assist preservice teachers in connecting curriculum and instructional practices. In addition, hands-on lesson planning provided preservice teachers with the opportunities to develop a deeper understanding of the interconnection between culture and mathematics. Thus, preservice teachers practiced and applied specific algebra content knowledge in the virtual world classroom to achieve culturally relevant mathematics teaching (Davis, 2013). According to Ladson-Billings' (1995a), teachers need to integrate culturally related content in lessons with meaningful curricula content that reflects diverse students' backgrounds.

Cultural knowledge. Cultural knowledge promotes equity in mathematics and addresses the needs of culturally diverse learners (Ladson-Billings, 1997). NMAP (2008) reported that historically, teachers' mathematics knowledge, as measured by teacher certification and educational courses, have not shown significant changes in underserved students' achievement. So, while there is a focus on mathematics standards, there is little attention on the cultural knowledge that teachers must possess to help all students achieve in mathematics. Therefore, the KATE Project centered their teacher preparation on PSTs' cultural knowledge and practices that are effective in classrooms with underserved students.

Problem solving. Problem solving is a key component for mathematics teaching that goes beyond conventional approaches. Problem solving is both challenging and rewarding for teachers because it pushes them to anticipate the misconceptions of students and reflect on their

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own misconceptions (Kulm et al., (2016). Problem solving requires that teachers have experience, confidence, self-awareness, and flexibility to engage students in discussions (Khisty, 1995). It embraces critical thinking, engagement, questioning, communicating, and interacting in specific instructional contexts (Ladson-Billings, 1997). Gay's (2010) suggests that teachers build bridges between what students already know and believe about mathematics and the new content they are expected to learn. The algebra problem-solving course provided a context that allowed PSTs to plan culturally relevant lessons that were meaningful and included real-world examples for middle grade students. For example, in problem solving, information for instruction is acquired through connections between teaching mathematics and the realities of the public-school classrooms.

Teaching practice. Teaching practices, which include various teacher preparation activities like observing classes and tutoring, are a major component of teacher preparation programs and a centerpiece of national and state standards for teacher preparation (Meyer, 2016). In traditional teacher preparation programs, teaching practices typically include student teaching as well as observation in classrooms, tutoring, research and similar activities (Meyer, 2016). Placement as a classroom teacher in one or more pre-K–12 schools under the supervision of an experienced teacher is part of a teacher preparation program (Meyer, 2016). A teacher's own way of thinking and behaving are influenced by race, ethnicity, social class, and language. Preservice teachers must critically examine their own socio-cultural identities and biases in the context of in-equalities diverse students' experiences. They must recognize and confront negative attitudes that they have about diverse student groups.

Gay (2010) argues that building transformative knowledge is important in mathematics education because it develops students' social consciousness to "combat prejudices, racism, and

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other forms of oppression and exploitation" (p. 37). Brown et al., (2011) posit that, besides knowledge of cultural practices, PSTs must experience what it is to teach mathematics to diverse students. Preservice teachers do not know if certain teaching approaches work unless they have an opportunity to try them out with underserved students. Ladson-Billings' (1995a) research suggests that teacher preparation programs provide systematic teaching practices for PSTs to engage in mathematics teaching with underserved students. Teacher candidates need the opportunity to interact with students in non-school settings where they are likely to experience success. Ball and Cohen (1999) argue that by focusing on the practices of teaching in the university classroom, PSTs are not limited by those enacted in a classroom. Without an opportunity to practice what they learn in coursework the information becomes lost or unused. The context of the experience-based, virtual, simulated middle school classrooms in Second Life presented the opportunity to align pedagogical theory with the practical realities of public-school classrooms. Through the SVC environment, PSTs performed teaching activities with a small group of middle grade avatar students while being coached by university instructors.

The KATE teaching-practice was contained by experienced university instructors who designed the culturally relevant problem-solving course. The teaching-practices in the KATE Project exposed PSTs to culturally relevant experiences and the problem-solving styles of underserved students. The use of SL technological tools allowed for the creation of new opportunities for preservice teachers to use real-life examples to engage students and encourage them in learning algebra content. By creating an integrated algebra simulation in a virtual classroom environment, preservice teachers had the opportunity to reflect on the framework of culturally relevant pedagogy practices in roleplay that did not arise in traditional teaching

placement schools. Thus, the SVC was an opportunity for PSTs to adopt instructional practices that are associated with culturally relevant instruction.

 Role-play. Role-play has been used to create replicas of real-life places that stimulate teaching practice. Aldrich (2009) explored the importance of role-play to increase student engagement. According to Aldrich (2009), SL simulation provided a structured experiential design with interactive variables that participants used to assume roles, make real life decisions, and experience the effects of those decisions in a safe environment. By using a Second Life, a Highly Interactive Virtual Environment (HIVE) was created based on games and simulation experiences, high interactions, and learning by doing. The context materials designed for role-play demonstrated ways of capturing high interactivity and nonlinear teaching and learning activities (Aldrich, 2009). One major problem was that the HIVE model in teacher preparation focused on games rather than an inquiry-based structure for learning practice (hands-on) experiences with real life objects. Planning activities led PSTs into discussing the topic of cultural diversity teaching and thinking about issues of equity that included culturally relevant pedagogy, critical pedagogy, problem solving, situated learning, and cultural awareness in planning lessons. By aligning curriculum and instructional practices with SL and the framework of culturally relevant pedagogy, teachers actively interacted with one another and the students using avatars.

 Finally, the opportunity to interact with others in SL provided a rich experience for reflecting. Getting feedback and self-reflection in SL was part of PSTs' training experiences to help them to evaluate their past experiences, perceptions, and approaches with the support of avatar students, peers, and instructors. Because virtual technology provided access to information through demonstrations, videos, and Internet links to expert teachers, PSTs received valuable

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feedback on lesson plans and to improve their teaching approaches when possible. Also, getting feedback from students and peers opens the lines of communication between teachers and students. Without feedback, it is difficult for PSTs to self-reflect on errors before making them in front of their students. In addition, self-reflection from feedback provides evidence for both teacher and student misconceptions, especially when feedback comes from students, peers, and university instructors.

Summary

The review of literature makes it clear that placing PSTs in the center of teacher preparation enhances their cultural knowledge and skills. Four teaching approaches are presented in this chapter review: (1) The literature review recognizes that learning mathematics does not occur in a vacuum, and that student's knowledge must be incorporated in transformative mathematics lessons. Equity, high expectations, and support for all students. I described the integration of mathematics and culture that starts the process of helping students to access mathematics content. (2) The literature shows that teachers may restructure the mathematics curriculum to incorporate key curriculum elements through real world examples and situated learning experiences of students. Therefore, I described situated teaching practices that draw on diverse students' knowledge to create meaningful and relevant curricula lessons for them. (3) The review includes literature on engaging students in the process of mathematics inquiry to provide opportunities for them to explore and critique mathematics knowledge. I described literature that used multiple representations to enhance communication and interactions with content and underserved students and promote active learning opportunities. Critical pedagogy and multiple perspectives provide preservice teachers with unlimited opportunities to enhance their skills and strengthen their own learning. (4) Although few examples exist that shed light on

teaching culturally relevant algebra lessons, such approach not only affirms teachers, but also motivates them to engage in knowing their students.

Finally, I conclude with how the KATE teacher preparation program has attempted to address preservice teachers' lack of cultural knowledge and skills to work in public schools. I highlight how the SVC represents a unique example of creating a context that aims to connect algebra problem solving coursework and teaching practice through virtual technology. I present the design of the SVC that allowed PSTs to pay attention to their needs and the needs of their students to enhance the experiences for teacher candidates who are learning to teach culturally relevant algebra lessons. This preparation allowed PSTs to reflect critically on their perceptions and experiences in the virtual simulation environment and acquire cultural knowledge and skills.

CHAPTER III

RESEARCH METHODOLOGY

Introduction

The aim of this chapter is to discuss the research method that guides this collective case study, also known as a multiple case study (Creswell, 2012). I employed a case study design to determine PSTs' perceptions and approaches in designing culturally relevant mathematics lessons. The interpreted approach incorporates the PSTs' reflections and perceptions of their experiences as mathematics teachers. In a collective case study, it is possible to understand multiple perspectives for the purpose of an "in-depth exploration" (Creswell, 2012, p. 465). A collection of cases is necessary to explore the preservice teachers' perceptions and approaches in teaching practice with culturally diverse students. Gall et al., (2007) gives an example of why particular cases are being:

> interested in teachers' interpretations of the act of teaching, that is, the meanings they ascribe to various features of teaching (e.g., lesson planning, student misbehavior in class, and homework assignments), to determine these meanings, the researcher needs to study particular teachers (local) rather than teachers in general (distance). (p. 24-25)

I begin this chapter with a discussion of a qualitative research method for a multiple case study structure. Next, I present information about the setting and process for selecting participants and obtaining data source. The final section details the methods of data analysis, the criteria for establishing trustworthiness and my role in the research. I conclude the chapter with a description of the limitations of this study. The findings in this study are presented in Chapter IV. Due to the need for a quality teaching workforce in diverse middle grade classrooms, this research concerns how the Knowledge for Algebra Teaching for Equity (KATE) project

structured preservice teachers' learning. Qualitative research method is used to examine how preservice teachers practice their teaching with underserved students in Simulated virtual classrooms in Second Life. This qualitative, collective case study examines PSTs' perceptions and approaches in a Simulated virtual classroom in Second Life.

Case Study Rationale

Patton (1990) notes that qualitative research "is an effort to understand situations in their uniqueness as part of a particular context and the interactions" (p. 1). A qualitative research design was used to analyze the approaches and perceptions of teacher candidates' responses to open-ended interview questions about their algebra problem solving course in post teaching practice reflections. This research was a multi-case study of eight middle-grade preservice teachers enrolled in coursework and teaching practice work. A multiple-case study design was used to (a) explore preservice teachers' approaches in teaching culturally relevant lessons during a problem-solving course, and (b) explore preservice teachers' perceptions regarding their teaching experiences in a simulated classroom in Second Life (SL). This method allows the use of a replication design, an in-depth analysis of the lesson planning process, the implementation of teaching practice, and the lessons learned from each participant as a unique case (Yin, 2009).

Creswell (2007) reports that a case study paradigm allows researchers to construct meaning through multiple contexts in which people live and work. In this case study, eight selected teacher participants share their teaching practice experiences as well as their perceptions of teaching practices in the SVC environment. Merriam (1998) shared that a "case study research in education is conducted so that specific issues and problems of practice can be identified and explained (p.35)." She added that a case study research is employed to

gain an in-depth understanding of the situation and meaning for those involved. The

interest is in the process rather than outcomes, in context rather than a specific variable,

in discovery rather than confirmation. (p.19)

Merriam (2009, p.43) presents three features of a case study as:

- Particularistic – case studies focus on a situation, event, program, or phenomenon for

  examining practice problems.

- Descriptive – case studies are rich descriptions of the phenomenon being studied to give a

  full, holistic picture of the case presented.

- Heuristic – case studies shed light on the understanding of strategies and techniques for

  problem solving by helping people rethink old constructs and acquire new knowledge and

  insights.

This case study is an inquiry about preservice teachers teaching practices and the potential is

to inspire prospective teacher development and education to improve the teaching process. A

case study is the most appropriate approach to optimize the understanding of preservice teachers'

teaching practices for three reasons: (1) to provide insight into PSTs' approaches to culturally

relevant teaching that are useful in diverse middle-grade algebra classrooms, (2) to improve

understanding of PSTs' perceptions and experiences in teaching algebra lessons to underserved

students, and (3) to understand PSTs' perceptions of gaining transformative experiences during

their teacher preparation coursework and teaching practice in Second Life.

Research Framework

The research perspective of this study resides in social constructivist and culturally

relevant pedagogy frameworks. The social constructivist framework rests on the assumption that

learning is socially constructed through individual interactions within their social worlds. In

explaining this framework, Creswell (2007) noted the basic social constructivist principle that multiple realities exist, knowledge is socially constructed, and biases must be revealed. Understanding qualitative studies involves reflecting on the realities, experiences, values, and beliefs of preservice teachers. Learning to teach has different meanings to different people. Learning to use cultural experiences in teaching practice requires PSTs to navigate through multiple contexts of the coursework and teaching practice environments. There are several socially constructed realities that are produced in the context of these interactions. Often, subjective meanings are formed through interactions with others in these contexts (hence social constructivism) and through historical and cultural norms in individuals' lives.

This study uses Ladson-Billings' (1994) framework to understand mathematics teaching practices that are embedded in classroom changes. From Ladson-Billings' (1995) perspective, culturally relevant pedagogy, combined with the elements of social constructivist paradigm is defined as new knowledge that is based on existing knowledge and experiences. As a paradigm, teaching that is culturally relevant focuses on instructions that empower students. Ladson-Billings' (1994, 2009, 2014) studies asked educators consider pedagogy content to empower students socially, intellectually, and politically. Similarly, CRP enables students to transition from passive to active recipients of knowledge that allows them to see themselves and their communities. As students gained academic success, they simultaneously gained understanding of their roles in their communities. Geneva Gay (2000, 2009, 2010), offered a similar framework on teaching called culturally responsive teaching (CRT), where practiced-oriented approaches encourage teachers to use instructions that validate students and their cultures. Gay asks teachers to use transformative teaching that values their own cultures while allowing them to teach the content material. In short, to be effective in diverse classrooms, preservice teachers must develop

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a deep understanding of how a broader content material impacts students' learning. PSTs must understand the pedagogical approaches to use in improving students' relationships to this content material.

Another perspective of the study is to use CRP and CRT to understand how preservice teachers' perceptions are reflected in their decisions about what to teach, how to teach, and to whom. Within the conceptual framework of culturally relevant pedagogy, the focus is on what teachers know and do to engage students in meaningful learning (Gay, 2010). A culturally relevant pedagogy framework employs the worldview that places the mathematics teaching within cultural context. Extensive research has examined equity issues in teaching approaches, learning activities, and algebra achievement, specifically regarding underrepresented students (Anderson, 2013, Kulm et al., 2016; Ball, 1990a; Moses et al., 2009; Lipka, 2005). While much of this study points PSTs education, equity in mathematics practices, and problem solving, this study further examines how PSTs' approaches and perceptions influence their enactment of teaching practice in middle grade algebra classroom with underserved students. Sleeter (2012) pushes for culturally relevant and responsive teaching in which learning is centered on meaningful curriculum and instruction for students. Understanding how preservice teachers' perceptions are enacted in diverse classrooms may provide insight into how educators prepare new teachers to work in public schools populated with ever increasing numbers of diverse students.

The KATE Project

Few qualitative research studies examine the perceptions and approaches of middle-grade preservice teachers in their teacher preparation programs. The KATE Project team sought to promote strategies that implement culturally relevant teaching in algebra problem solving that

challenge preservice teachers' cultural knowledge in a simulated classroom in Second Life. In the KATE program, preservice teachers needed to understand that mathematical knowledge "is situated within a socio-cultural frame of a given cultural group" (Ukpokodu, 2011, p. 51). Further, preservice teachers needed to understand that algebra is a gatekeeper to advanced mathematics learning for underserved students because algebra skills serve as the entry point into high school mathematics courses. Lack of knowledge in algebra limits students' opportunities to succeed in future careers. Therefore, the intent of the KATE Project was to create a teaching intervention that increases the understanding of preservice teachers' perceptions and approaches as they teach diverse students.

A focus on preservice teachers' perceptions of their experiences is necessary for current classroom improvement initiatives (Nelson & Guerra, 2013). Thus, this qualitative case study grew from the KATE Project that created an environment in Second Life that provided opportunities for preservice teachers to practice teaching lessons. The overall goal is to 'hear' the muted voices of preservice teachers by examining how they perceived their experiences and planning approaches for teaching culturally relevant algebra lessons to diverse middle-grade students.

Research Setting

The setting for the research was situated within a southwestern university, a curriculum and instruction department, and a simulated virtual classroom in Second Life. Although the purpose of this study is to gain understanding of the perceptions and approaches of preservice teachers in learning to teach algebra lessons during their problem-solving course, this case was a bounded system, bounded by time (14-weeks) and place (situated in a simulated classroom). Creswell (2007) defines a case study as:

an exploration of a 'bounded system' or a case (or multiple cases) over time through detailed, in-depth data collection involving multiple sources of information rich in context. (p.73)

The virtual simulated classroom represents a unique structure that aims to connect the MASC problem solving coursework and teaching practice for PSTs. This classroom was a constrained environment in which different conceptions of teaching practice emerged, depending on how preservice teachers perceived their simulated virtual classroom experiences. So, the boundary of this case does not reflect actual teaching practices beyond this environment. The eight preservice teacher participants shared their time, experiences, teaching strategies, and reflections during a 12-week period in fall 2013 and spring 2014.

The Integrated Mathematics and Science (MASC) Problem Solving course initiative was a practice-based middle-grade course grounded in mathematics coursework and teaching practice in Virtual Simulated Teaching practice learning. The course focused on student problem solving and culturally relevant pedagogy within the context of a middle-school mathematics classroom. The course lasted 14 weeks, or the approximate length of a semester, and focused on preparing preservice algebra teachers for diverse classrooms. This MASC course was used to support preservice undergraduate mathematics students at Texas A&M University as they learned to teach culturally relevant algebra lessons. Most importantly, this course incorporated broader algebra curriculum content appropriate for diverse middle grade teaching and learning. The course attempted to strengthen the cultural knowledge of PSTs' and algebra knowledge as a foundation upon which they will develop and build diversity awareness, pedagogical content knowledge to use in teaching students from diverse backgrounds. Another focus was to assist PSTs to plan a curriculum and teaching content that was relevant, broad, and aimed at providing

PSTs' with an understanding and knowledge of teaching algebra for equity. Lessons plans that are meaningfully connected to students include multiple representations, students' preexisting knowledge, and active instructions in teaching plan.

The course instructors used culturally relevant pedagogy to assist PSTs as they planned lessons for diverse learners. Preservice teachers engaged CRT lessons planning, providing real-life examples, and practicing teaching their lessons to underserved students in a simulated classroom in Second Life at the end of the semester-long mathematics course. Furthermore, the lesson planning required that PSTs' practices align with culturally relevant teaching. The aim was for PSTs to achieve culturally relevant pedagogy knowledge that improves algebra teaching for diverse learners. Consequently, PSTs created a 20-minute algebra problem solving lesson that was implemented as a practice-based activity using these conceptual schemes: situated learning or culturally relevant teaching or critical pedagogy. As a starting point for PSTs, the topics of the lesson plans were selected by PSTs within the CRT framework with the intent to teach diverse middle-grade students. Then Preservice teacher participants taught their problem-solving lessons to engage student avatars in problem solving, observed each other's work, and reflected on their simulation practice sessions, including difficulties and misconceptions. These were just a few of the prominent activities that occurred within the MASC course within which course time was dedicated to.

Most importantly, the KATE team created Glasscock Island, an indoor Simulated virtual classroom built as a middle school site in Second Life. This was a replica of a real-life classroom setup for PST participants to practice teaching within the context of their teacher preparation program (Savin-Baden, 2011). Creating a SL environment provided a unique method of training PSTs to meaningfully interact and participate in role-play teaching, tutoring, and collaborations.

This teaching practice environment introduced PSTs to new foundations of virtual simulation learning, culturally relevant teaching, and classroom diversity. Thus, the teaching practice was conducted in a simulated virtual classroom located in SL at Texas A&M University where preservice teachers interacted as teacher avatars (virtual characters that represent real teachers). The intent was for PSTs to experience algebra classroom teaching with diverse middle grade avatars (students). Preservice teachers were encouraged to participate in this Simulated virtual classroom teaching under the support of the KATE leadership. The main purpose was to enhance their cultural awareness knowledge and algebra problem-solving skills to prepare them for diverse classrooms. Additionally, the context of the simulated virtual classroom structure provided opportunities for PSTs to learn how to teach. In their teaching practices, the participants had 20 minutes of teaching experiences that were completed in the SVC with middle-grade avatar students.

Simulated Virtual Classroom (SVC)

In the simulated virtual classroom (SVC) environment in Second Life, PSTs assumed virtual characters that represented real teachers. In other words, the context in which teaching and learning happened in the KATE's Simulated Virtual Classroom in SL. This SVC was created to provide a rich context to situate the study and use a variety of simulation-based teaching, learning, and role-play. The student avatars posed as middle grade students to allow preservice teacher avatars to teach problem-solving and address students as well as their misconceptions. These avatars interacted with each other through conversations and gestures (Gao, Noh and Koehler 2009) in a non-scripted role-play simulation discourse. Thus, the KATE team made structural modifications within the university course to provide a teaching-practice environment

for PSTs to practice teaching culturally relevant algebra lessons with students (graduate students) avatars.

The classroom also had a mix of programmed electronic "bots" (programmed to respond to teacher avatars) that were operated by a fellow avatar student. The programmed bots displayed controlled questions to ensure that the teacher avatar was exhibiting cultural knowledge and skills, such as calling students by name and acknowledging when they raised their hands or had questions. The goal was to enhance PSTs' experiences within the course so they would critically examine and reflect on their teaching practices. It was also to improve mathematics teaching in a diverse classroom based on specific curriculum materials and pedagogical practices. Through audio and chat interactions, PSTs presented questions to be addressed throughout the lesson period. This enabled preservice teachers to experience situated learning, knowledge and skills to handle real life classroom situations.

Figure 2: PST in the KATE's Teaching Practice with Students in Second Life

Figure 2 indicates a notable experience for PSTs which is important to conceptualize the context of algebra teaching-practice. The SVC was designed by the KATE's Project to bridge the gap between algebra coursework and teaching practice experiences and to promote culturally relevant mathematics teaching. Thus, this SVC setting supported eight PSTs in their algebra lesson planning and teaching and to work with diverse others (students, peers, course instructors) to exchange ideas that connected culturally relevant teaching with students. Therefore, the course positioned PSTs in a SVC environment that connects the algebra coursework to the realities of teaching in a culturally diverse public classroom. The KATE Project enhanced teacher preparation and PSTs' practices in teaching relevant and meaningful algebra topics to underserved students.

Participants

Central to this case study are the participants from the MASC algebra problem solving course. Participants were eight middle grade mathematics preservice teachers enrolled in a

required mathematics problem-solving course: Integrated Mathematics and Science (MASC).

Middle-grade preservice teachers enrolled in this undergraduate teacher preparation program in

fall 2013 and spring 2014 as part of their degree program. A total of 19 preservice teachers (9

from the fall of 2013 and 10 from the spring of 2014) completed the course requirements and the

interview process. Out of the nineteen participants, eight were selected for this study from the

two consecutive semesters: four from fall 2013 and another four from spring 2014. The

participants vary in ethnicity: five were Caucasian: Rachal, Abby, Katy, Tori, and Tanya; two

were Latina Americans, Sofia and Diana, and one was an Indian American, Linda. The eight

selected were all female and identified themselves racially as Caucasian, Latina, and Indian

American. As is the case with most middle grade algebra classrooms, the selected preservice

teachers are typical of the teacher population in public schools teaching underserved students.

They have the typical demographic characteristics, mostly non-diverse, predominantly White,

with middle-class socioeconomic backgrounds. On the other hand, they are an ideal population

for the KATE Project for planning SL teaching activities. They are members of the digital

generation who have interest in working with virtual tools such as SL.

Purposeful Sampling

The participants were selected using "purposeful sampling" (Creswell, 2012, p. 207) to

represent different cases of cultural awareness and mathematics teaching experiences. The use of

a case study requires that I establish a rationale for purposeful sampling that includes selecting

and gathering background information for each case participant. This is a non-random method of

sampling through which interview transcripts are identified to provide information rich cases. I

drew on purposeful sampling to employ maximum variation as a strategy and acknowledge

opportunities for an intense study on the cases selected. Also, purposeful sampling helped me to

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select multiple cases to show different perspectives of the preservice teachers' perceptions and approaches. With this selection, the research attempts to gain a common pattern of PSTs' perceptions with their semi-structured interviews. Thus, the goal for selecting these participants was to gain a further understanding of their experiences and activities in the classroom with underserved students and their disposition that contributes to their learning how to teach. Hopefully, this variation in teacher participants may lead to different findings.

According to Patton (1990), information-rich cases have the potential for in-depth learning through discovery, insight, patterns, and understanding of the problem. Patton (1990) writes:

> The logic and power of purposeful sampling lies in selecting information-rich cases for in depth study. Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of research, thus the term purposeful sampling. (p.169)

In this case study, I was looking for the quality of information rather than the volume. The eight participants allowed me to examine their experiences in the virtual context of a classroom in the teacher preparation program. The participants ascribed meaning to their classroom experiences that was interpreted within the socially constructed model. Information about preservice teachers was self-described in terms of their ethnicity and not explicitly requested, but whenever stated, preservice teachers' information was shared. Another rationale for selecting these cases was to have enough information to present an in-depth picture of the case. Creating balance and variety is important, but the opportunity to learn from the case is even more important. Thus, the primary criterion was to have the opportunity to learn from the attributes of interest in the case.

Finally, I selected these teacher candidates to gain a diverse perspective of the ways in which they are experiencing the context of teaching underserved students.

Furthermore, Patton (1990) believes that, with purposeful sampling, the researcher uses the power of a small sampling procedure to describe how information in the appropriate context is necessary for judging the sample. Overall, the teaching approaches that I am looking for are aligned to the attributes noted by Ladson-Billings (1994). In addition to attributes established by Ladson-Billings' research, the evidence about the PSTs' perceptions of their classroom practices is included. These teachers were taught to design effective lessons and provide opportunities to interact with diverse students in a supported environment. To find similar characteristics, the criteria for selecting the eight preservice teachers were: (a) no prior experience in planning or teaching culturally relevant algebra problem-solving lessons, (b) no prior experience in public school classrooms, and (c) no prior experience with classroom simulation in

In addition, I selected participants with differing levels of experiences. For example, one PST has used Second Life virtual technology in gaming since she was 13 years old. Linda, a White female candidate, has early experiences with SL playing games; however, she has no prior experience as a teacher nor is familiar with a non-traditional school environment. In contrast, Diana lacks virtual technological experience in Second Life but has been in a classroom setting with non-diverse students as a passive observer. Another participant reported observing a classroom that was parallel to her educational experiences growing up. The eight PSTs selected offer an opportunity for in-depth descriptions of their perceptions and approaches in planning lessons. Therefore, a variety of participants would allow me to cross check responses and seek out evidence to disconfirm my findings. Table 2 below provides a brief overview of the eight participants and information pertaining to their self-identity. In effort to protect their identity,

pseudonyms are assigned to all preservice teachers and used in this study analysis and in the research findings.

PSTs' Name (pseudonym)	Ethnicity*	Teaching Practice
Linda	Caucasian/Indian	No
Tori	Caucasian	Yes
Diana	Caucasian /Latina	Yes
Abby	Caucasian	Yes
Sofia	Caucasian/Latina	Yes
Rachal	Caucasian	No
Tanya	Caucasian	No
Katy	Caucasian	No

Table 2: Self-identified Characteristics of Participants

In order to examine the interactive processes by which preservice teachers supported their teaching practices, I used data from their interview transcripts to answer the research questions. Archival data from the Integrated Mathematics and Science (MASC) algebra method course was the primary data source for this study. I did not interview the preservice teachers, but my petition to use archival data from the KATE algebra problem solving course was granted for fall 2013 and spring 2014 and used for the analysis. The interview data was requested from the KATE

Project leadership and provided for two semesters: fall 2013 and spring 2014. The data was obtained from the KATE research project as part of the algebra problem-solving course to guide middle school mathematics teaching for preservice teachers in diverse classrooms. To summarize, a KATE Project associate conducted and transcribed interviews with nineteen middle grade preservice teachers who enrolled in the undergraduate MASC mathematics course. The transcribed verbatim generated 5-8 pages of data for each teacher participant in the interview sessions that lasted approximately 40-50 minutes.

The purpose in using interview transcripts from the KATE MASC coursework was two-fold: To obtain understanding of PSTs' perceptions of their experiences with (algebra content, self-competence, diverse students, and active teaching), as well as to examine their approaches to curriculum and instruction (lesson planning, student engagement, and teacher expectations). Also, this data source was selected to provide the best opportunity for an in-depth analysis of each individual PST's transformative experiences related to teaching and learning culturally relevant algebra lessons. Thus, this archival data covers the topics of preservice teacher perceptions, approaches, reflections, and transformation. The data was drawn on their interactions as teachers learning how to teach, and the transcripts provide in-depth responses of preservice teachers' experiences. Therefore, using this data source allows for insight into PSTs' voices and reflections of their experiences. Also, with this transcribed interview data, I present direct quotes to communicate through the experiences of PSTs. It is hopeful that a holistic picture and understanding of preservice teacher perceptions and approaches in this study will be achieved.

Research Questions

        The research questions are descriptive about the interactive processes by which preservice teachers designed culturally relevant lessons. The research questions are not designed to compare the outcomes of different teacher interactions, but to examine individual interactions within a. teaching context, particularly how preservice teachers structured their teaching plans and implemented their ideas in the context of the SVC environment in Second Life. There were two research questions:

1. What are preservice teachers' approaches in teaching culturally relevant lessons during a problem-solving course?

2. What are preservice teachers' perceptions regarding their teaching experiences in a simulated classroom in Second Life?

I concluded with the examination of PSTs' experiences, and what they learned about teaching culturally relevant algebra lessons.

        To listen to the participants' perspective in this study, PSTs were asked open-ended questions to explore their understanding of teaching practice. The interview questions focused on the knowledge and experiences of PSTs. Teacher candidates are interviewed individually and presented a series of challenging informal questions that are descriptive of their thoughts about planning lessons, culturally relevant teaching, and engaging students. This open-ended, informal interview process is a mixture of conversation and information gathering techniques that allow the opportunity to clarify, extend, and explain certain classroom events. The specific set of open-ended questions gives each PST the opportunity to reflect and share details about their experiences and instructional decisions. These decisions are relevant to their teaching practices throughout the duration of the MASC problem-solving course.

During this interview process, PSTs were reminded that there are no rights or wrong answers, and they were often prompted to interject information that they perceive as relevant. The general question asked participants to describe their teaching plans and explore their perceptions of success or failure instructional approaches. For example, the interview process started with broad questions that became more specific as the interview progressed, such as, "What worked and didn't work in your teaching plan?" Later, the questions were followed by specific reflections of their teaching experiences, such as "Was there something that frustrated you during your teaching experience?" Thus, they engaged in a reflective process of sharing personal and teaching knowledge of their classroom practices.

Often, the interview questions serve to explore PSTs' diversity and cultural knowledge awareness, including knowledge about underserved students and pedagogical content. To gain a deeper understanding of how PSTs perceived their interactions with these variables, the interview questions delved into their understanding of situated knowledge and culturally relevant pedagogy. This process allowed PSTs to move back and forth in reconstructing their teaching experiences and interpreting lessons learned. Toward the end of the interview process, each teacher participant had the opportunity to inquire about the course and extend their own feelings and opinions about their teacher preparation programs. In other words, they reflected on their potential changes, such as if their perceptions of teaching mathematics, how the simulated virtual classroom teaching had changed, and if they had learned anything from interacting with diverse avatar students. Thus, the open-ended interview questions consisted of data for: (1) algebra knowledge, (2) cultural knowledge, (3) problem solving skills, and (4) diversity awareness growth. The teachers were asked their thoughts about their performances, which included:

- Setting goals and creating meaningful curricula experiences for themselves and students

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- Participating in Second Life activities and role-play

- Engaging and solving problems

The interview questions focused on what preservice teachers learned during their MASC coursework and teaching practice. This includes their teaching plans, instructional strategies, interactions, and enactment of algebra lessons in SL. With this transcribed interview data, it is hopeful that a holistic picture and understanding of PST participation is achieved along with an analysis of their approaches and experiences. Sample interview questions can be found in Appendix A.

Data Analysis

The researcher employed two leading data analysis procedures: (1) the within-case and (2) the cross-case analysis (Creswell, 2012; Merriam, 1998). The data analysis process for each of the interview transcripts was separated into phases. The first method involves deconstructing the transcript into question segments to capture their overarching approaches. Then, the segments were analyzed according to the three dimensions of Culturally Relevant Pedagogy framework. Based on these characterizations, each instance was indicative of PST's cultural knowledge and their teaching plan with underserved students. More specifically, the analysis affords the identification of differences in various instructional approaches and teaching plans.

In order to answer the research questions in the study, I drew upon the two-step method of analysis and allowed the in-depth descriptions and comparisons of preservice teachers in multiple perspectives. First, I deployed a "holistic" analysis in which each case is a comprehensive development. Creswell (2007) states that the first step in analyzing a multiple case study is to describe each case and its themes, which is called a within-case analysis (p.75).

The individual case analysis is focused on reading, organizing, and classifying each participant's interview transcripts.

The second part of the analysis is looking for substantive differences in the instructional approaches and perceptions. This analysis follows the cross-case method (Creswell, 2007) in which the researcher engaged in constant reflections to ensure that larger claims about the participant are representative in the evidence. The cross-case method compares individual cases to examine the perceptions and teaching approaches of PSTs along with the themes and issues that emerge from the MASC course. Cross-case analysis is a process of comparing questions and responses across cases to encompass individual cases. The researcher looked for meaningful experiences across the question segments, probing for the kinds of instructional approaches that existed and the differences between the instructions. The information was classified using broad themes to characterize the instruction and the PSTs' teaching plan.

Data Analysis Procedure

According to Creswell (2007, 2012) data analysis procedure in a traditional case study method follows seven components:

1. Read through transcript text and highlight important information.
2. Organize the pre-defined interview questions.
3. Look for descriptions and facts in the text.
4. Use classification to identify patterns or themes.
5. Use direct interpretation.
6. Develop naturalistic generalizations.
7. Present in-depth picture of the cases.

Within-Case Analysis

Saldaña (2009) advocated grasping "basic themes or issues in the data by absorbing them as whole … rather than by analyzing them line by line" (p. 118) to define holistic analysis. First, I used the within case method and the interview questions from the participants to start the data analysis process. The aim of the individual case analysis is to describe interactions and present a viewpoint of how preservice teachers experienced their teacher preparation program. In order to answer the research questions, I began the process with an initial review of all interview transcripts that captured PSTs' responses and their individual interactions. I looked for differences and similarities in their responses because the research questions are concerned with their separate approaches and perceptions of learning. I read each response multiple times to get a basic understanding of the issues emerging from the text. As Saldaña described, this strategy allows the researcher to deepen their understanding of the participants' views and use their language "rather than terms derived from the academic disciplines." As I read through the data multiple times, I looked for important descriptions to fit into categories, highlighting the responses of all potential themes. I posed questions about certain areas for further examination. After multiple readings, I regrouped the data from the original questions under appropriate broader categories of the two research questions. According to Lincoln and Guba (1985), "data analysis involves taking constructions gathered from the context and reconstructing them into meaningful Wholes." (p. 333).

I focused on the classroom practices that PSTs were tending to as they shared their teaching experiences. As I read the interview transcripts multiple times, I separated the interview responses that represented pedagogical concepts (lesson planning, student engagement, critical pedagogy) to get a clear pattern of PSTs' responses. I identified patterns about perceptions,

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misconceptions, interactions, transformation, and growth. I examined the extent to which each individual response supported the research questions, including the types of teaching plan, student-teacher engagements, experience planning lessons, (how PST planned CRT lessons to engage with students) and teacher-math interactions (what algebra problem solving topic was taught). This pattern allowed me to focus on my first research question: What are preservice teachers' instructional approaches in teaching culturally relevant lessons during a problem-solving course? For example, in the lesson planning and delivery, several cases revealed two strategies: conventional and culturally relevant. The conventional pattern has preferences for passive approaches to instruction (memorization) and culturally relevant lessons that vouch for student engagement (hands-on, communication). Thus, the type of lesson plan offers an understanding of the PSTs' knowledge of CRT and influences how they plan their specific approaches to teaching. By revealing how PSTs planned their lessons, the analysis 'hears' their voices as they reflect upon their experiences in the middle-grade simulated virtual classroom setting. I combined this finding by drawing on the interview data transcripts to analyze my second question.

Organize and describe. Yin (2003) suggests that collective case study design uses logic of replication, in which the inquirer replicates the procedure for each case. First, I used interview questions to establish categories for each individual preservice teacher. Then, I used the descriptions to identify similarities and differences within the established questions. I used the PSTs' descriptions to identify elements that are interpreted as culturally relevant teaching approaches. I assigned names to descriptions that are relevant to my research questions: curriculum topics, instructional strategies, culturally relevant lessons, teaching practice experiences, algebra problem solving techniques, simulation classroom, diverse students, and

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other relevant attributes. I recognized the significance of the research questions. I repeated the process to create a within-case analysis for each of the eight selected preservice teacher participants.

Classify. I grouped original interview questions under appropriate research questions and looked for corresponding categories of instructional approaches, perceptions of experiences, and reflections. The central step in classifying this data was to combine questions into meaningful segments that form newer, broader descriptions of the data. Further support for the findings was done through the descriptions provided by preservice teachers. For example, PSTs' perceptions provided opportunities to draw on their coursework and teaching practice experiences that ascribe the meaning of contextual factors to their teaching approaches. I read this information to determine how PSTs' perceptions fit into the teaching underserved students. Then, I examined the SVC factors that provided the opportunities to build interactive and active experiences. I began separating active experiences into engagement, communication, SL activities and diversity experiences. I examined the extent to which each component of their perceptions supported PSTs in paying attention to the important aspects of their classroom practices. This process of category development is consistent with the principles of case study that derive categories taken directly from data rather than from theories written by other researchers (Gall et al., 2007).

To reduce redundancy across data, the related transcript aspects from teaching plans are counted once. Similarly, PSTs' multiple descriptions of the same concepts are included once and only when sentences are used in different contexts. The researcher aimed to include instances that are distinctive to reduce redundancy. Furthermore, the interview transcripts are used to confirm instances of support or challenge assertions based on the PST's accounts of actions and experiences.

After developing these categories, it was necessary to decide whether the construct fits into the concept of the research question. If it did, I assigned it to the question. Another strategy was to develop categories by identifying the significant occurrences in PSTs' lessons and determine their shared similarities. A single interview response provides various types of information that are assigned to multiple categories. This inductive approach allows the re-organizing of descriptions that are derived from interview questions. The individual findings show the major differences from PSTs regarding their perceptions of mathematics, curriculum and instruction, and diversity. The individual analysis shows that there are practical changes in the PSTs' perceptions of their experiences in the teacher preparation program in Second Life. The findings from each of the within-case analysis were cross-referenced to examine commonalities and support for all cases.

I employed the classification of data into instructional approaches, culturally relevant topics, PSTs' perceptions, experiences, and additional categories during this data analysis. This process transitions from reading to forming themes through reclassification. The names of the themes are drawn from what I expect to find from literature and what seems to describe the information best. Through classification, I look for contrasting patterns of preservice teachers' perceptions and approaches in their teaching practices. I further identified patterns of similarities and differences to show each preservice teacher's knowledge and skills. I grouped responses that indicate a more passive approach and a more culturally relevant approach to mathematics teaching. An example of a contradiction is a positive response to the statement "I tried to answer their questions" (interview question, Q7) and a negative response to the statement "is there was only one way they could have done it" (interview question, Q10). In addition, without additional data from preservice teachers, some responses called for further inquiry into the analysis process.

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I analyzed PSTs' expectations of themselves, the students' positive and negative experiences and their interactions in creating teaching plans and setting goals. Finally, I focused on the impact of the course that includes feelings and opinions. I reported the changes in the perceptions of PSTs' teaching of students and teachers in the algebra problem solving course.

Cross-Case Analysis

The cross-case comparison analysis is a process of comparing segments within and across categories. I chose the Cross-Case Method as the secondary analysis technique for the study. The cross-case method uncovers emergent themes and patterns to develop meaningful accounts of instructional practices, experiences, perceptions, and reflections. This level of the analysis compares PSTs' interview transcripts in search for common themes and discrepancies across individual cases. The cross-case method (Merriam, 1998) is a process of comparing multiple case data. This method compared the interview responses in the open-ended questions and integrated similar responses. Merriam (1998) identifies five key benefits of the cross-case method that support the purposes of this study. The first benefit is the examination of complex social units that contain multiple variables to help in understanding the phenomenon. The second benefit is the rich holistic account of a phenomenon. Cross-case analysis offers insights and meanings that expand the readers' experiences, and this is identified as the third benefit. The fourth noted benefit is the interpretation of insights that are tentative to structure future research. The goal is to build general explanations that dissect individual cases.

To synthesize interview responses that emphasize similarities and differences, I establish patterns that are relevant to my two research questions and develop conclusions based on the entire data analysis. The findings from each of the within-case studies were cross-referenced. The process includes noting whether a theme observed in one case is similar in other cases. By

comparing similarities and differences among the types of teaching approaches, the opportunity to understand PSTs practices was presented. If there were similarities, the data were combined. I also examine the extent to which each component of the MASC course activity has supported PSTs in paying attention to the important aspects of the classroom practice. Second, in this analysis, themes are formed into categories that relate to the research questions (instructional approaches, perceptions of teaching experience in simulation) in addition to other similarities and differences that are not directly related to the research questions (feelings, lesson learned, opinions). To support the process of comparing and contrasting cases, the research sought out the relationships between the preservice teachers' approaches and the perceptions that emerged from teaching practices. For example, I explored similar perceptions of mathematics that may or may not be related to teaching mathematics to culturally diverse learners. Thus, this analysis responds to the second research question: "What are preservice teacher's perceptions regarding their teaching experiences in a simulated classroom in Second Life?" Finally, a conclusion based on the entire data analysis was developed. I identify preliminary perceptions of each preservice teachers' teaching approaches to teaching algebra lessons. Analysis for the first research question produced four overarching themes: teaching plan, teaching practice, meaningful engagement, and low expectation.

The same steps were taken to analyze the data for the second research question and report on the perceptions of the participants. Thus, this last analysis responds to the question: "What are preservice teachers' perceptions regarding their teaching experiences in a simulated classroom in Second Life?" The process of comparing cases was used to seek out the teacher candidates' perceptions. Research question two developed the main themes of the PSTs' perceptions of themselves as teachers, mathematics, diverse students, and CRT competence. For example, I

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explored a similar perception of learning mathematics that was related to a similar method of teaching mathematics. I compared the cases to seek out the PSTs' perceptions of experiences and develop meaningful accounts of their classroom interactions. Thus, the analysis focused on the following four main themes from teacher perceptions: perception of CRT, perception of students, perception of mathematics, perception of teaching presence.

Direct interpretation. Through direct interaction with the data, I used an "inductive" (Creswell, 2012, p. 238) data analysis process to browse through numerous cases and develop broad themes or categories related to my research questions. Interpretive analysis holds that data was examined to find construct, themes, and patterns that are used to describe and explain events being studied (Gall et al., 2007). Stake (1995) and Lincoln and Guba (1985) advocated for a form of analysis that includes direct interpretation into case study research. This phase constitutes the "lessons learned" from descriptions of participants' learning through experiential knowledge. Stake embraces it as a process of pulling the data apart and restructuring it in more meaningful ways. I also reported on the reflections from teacher candidates in their coursework and teaching practice s during algebra problem solving course. Although PSTs drew upon their past and current experiences to plan algebra content, the algebra problem-solving course had a significant impact on them. Most of the PSTs reported that their participation in the course and teaching practice made them more aware of the different needs of culturally diverse students. Looking across cases for the impact the course made, I identify these themes from lessons learned:

Both positive and negative coursework and teaching practice appeared to impact PSTs beliefs. Although their past experiences had effects on their beliefs regarding underserved students, they had a better understanding of diversity issues after their training practices. PSTs

were positive about using SL virtual classroom experiments. I used my interpretation based on PSTs' insights to create active views of teaching approaches to form a broader meaning of teacher preparation situations. The themes were collapsed into larger themes, such as personal and pedagogical skills, to reflect on their self-growth, thereby ending the two-level analyses.

Toward the end of the analysis, I combined these themes into four overarching themes to engage low expectations, water curriculum, inactive teaching practice, as well as perceptions of self, students, and mathematics and lessons learned; thus, providing the second layer of analysis and broader interpretations of preservice teachers' approaches. Finally, I determined if the data analysis showed patterns of inconsistency among the preservice teacher's perceptions across the interview process and pointed them out in my findings. For example, some PSTs perceived they interacted with avatar students during their practice lessons, but then most statements they made about teaching practices indicated that they followed passive teaching methods of direct instructions. This way, an interpretive mode of inquiry seeks detailed descriptions of perceptions that are relevant to highlight meaningful themes of the study. Finally, it is necessary to present an in-depth view of facts about the case via visual support. I report the meaning of the case that comes from learning about its issues to establish patterns and correspondence. Further, the illustration shows inductive analysis that begins with data source information and then broadens to specific themes.

Trustworthiness

In a collective case study, it is critical that data collection and analysis are conducted in ways that deal with issues of trustworthiness (Lincoln & Guba, 1985). In naturalistic research, trustworthiness is established by addressing credibility, transferability, dependability, and conformability. For this research study, trustworthiness is achieved using thick descriptions and

reflexivity. In order to provide this description, I selected participants who contribute information-rich cases to the study. I presented the findings with original sources of data, such as direct quotes, research context, and descriptions, to communicate the findings through the PSTs' voices. The participants and the setting are contextualized with the inclusion of details. Throughout the process of data analysis, I made efforts to establish trustworthiness, and I briefly address each of these criteria.

Credibility. This aspect of trustworthiness refers to the extent to which the findings of the study match the approaches and perceptions of preservice teachers. To ensure that the findings accurately reflect PSTs' perspectives, I tried to paraphrase what the participants said and reviewed about each theme across participant responses so that I understood the meaning they were trying to get across. This approach promotes credibility and works to establish transferability.

Transferability. In qualitative case study design, generalization does not happen from sample to population. The interest is in the "process rather than outcomes, in context rather than a specific variable" (Yin, 2003, p.19). It is essential that the research report is descriptive because generalization is dependent upon situated context. The researcher must provide enough details for the reader to make a generalization or "working hypothesis" (Lincoln & Guba, 1985) about their own context or situation. In order to provide this detail, I present the reader with direct quotes and illustrations to provide a perspective of the simulated virtual classroom teaching practice and the participants' own perceptions and experiences. I document important features of their teaching plan so that the reader applies the knowledge they gain from the study to their existing knowledge, personal context, and understanding.

Dependability and Conformability. The goal is to give the reader a thorough understanding of the research design and methods of analysis and allow the reader to understand PSTs' situated and perspectives transformation. In order to establish dependability of the analysis process such that others may conduct a similar study, I describe the context and analysis methods in detail. In order to meet the criteria for conformability, or the degree to which others corroborate the results, I kept the data transcripts.

Reflexivity

As a participant, I was reflexive about my position within the study. An important characteristic of a case study is the effort to present the outsider's perspective called the "Etic perspective" and the perspective of the insider known as the "Emic perspective" (Gall et al., p.450). This perspective assists in establishing credibility by disclosing my biases and assumptions as an avatar student participant and as an African American graduate student in the study. My conclusion and reflection brought my personal experiences into the discussion without disrupting the flow of the study. My interpretation of the data was filtered through many lenses which accompany me through this research journey, in addition to being African American, a mother of two children that attended public middle schools. In each role, I found myself on many occasions advocating for African American students in some capacity.

As an Avatar student, I began my journey by constructing my avatar to resemble a diverse middle grade student for the purpose of my role-play in the Second Life simulation. In this portrayer, I was a seventh grader with an ethnic and culturally diverse background, who qualified as a low-income student with limited algebra knowledge and English language proficiency. Thus, I described my avatar name, gender, ethnicity, grade level, and qualification for free lunch at school. This made me an ideal student that prospective teachers would

encounter in public school classroom settings. Furthermore, in preparation for my role as an avatar student, I used the KATE team's planned objectives and strategies for interacting with avatar preservice teachers during their teaching practice session in SL. I attended several pre-simulation planning sessions with other avatar students, course instructors, and KATE designers in preparation for the forthcoming interactive activities.

During these sessions, the lesson plans submitted by PSTs were discussed to identify algebraic misconceptions and diversity issues that underserved students have. The purpose was to prepare non-diverse preservice teachers to acquire cultural knowledge and skills and work more effectively with their future diverse students. The responsibility of the avatar student then was to give feedback by asking unstructured misconception questions like what a typical culturally diverse student in a middle-grade algebra public classroom setting would ask the teacher. First, the questions were supposed to challenge PSTs' cultural knowledge and determine if PSTs' perceptions about underserved students' lives and other characteristics impacted how they interacted with them. Although the study was designed to gain understanding of how preservice teachers' perceptions affect their approaches in teaching algebra to culturally diverse students in public school settings. From my perspective acting as an avatar student, I gained valuable insights into the perspectives of the selected non-diverse preservice teachers. In addition to uncovering my own perceptions as an African American student, taking this step allowed me to gain insight into the complex task of preparing teachers for culturally relevant teaching and the issues related to teaching and diversity. In the end, my role-play as a middle grade student avatar enlightened my insight as well as knowledge of teaching and addressing students' misconceptions.

As an African American woman and a professional, it is important to acknowledge that my subjectivity impacts this work. First, my lived experiences through my education and employment include my silent voice in conversations and discussions about race and ethnicity. Even when the discussion at hand concerns the experiences and needs of persons of color such as me, my opinion was not always disclosed as a solution to the problems discussed. In the same regard, I look at myself as "the other" or exclude myself from contributing to my perspective. When asked, I feel pressure to respond and defend the entire African American race. In either situation, I quietly vouch for my honest intent and consider my interest in the discussion.

As an African American student, who chooses to continue her studies in education, I believe in the power and potential of education to transform my life. I realize that my own personal experiences both as an African American and a student may have helped filter my perception of effective teaching. Since my undergraduate degree is from a historic African American university and for over 10 years, I worked in the same environment. My experiences just like those of the PST participants in this research impact, how I "see" the world. Therefore, my interpretations of the findings in this research are filtered through the lens of my own lived experiences, understandings, and perceptions. I have also struggled to make connections to my own experience and often find myself seeking balance in these struggles to achieve. My own thinking and development have been interwoven in this study to reveal my professional goal to take responsibility to serve and validate my own voice and the experiences of others.

Last, my role as a mother positioned me as an "outsider" which added another layer to my perspective. My experiences as a parent have shaped my participation in this study and I found several areas that require me to challenge my subjectivity. As an outsider, I examine how authentic their responses were and probed further for my understanding being mindful that self-

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reflection depends on individual perspective. I wanted to hear positive "perceptions" from preservice teachers as they share their thoughts about diverse students. Although, I am very much aware of how negative perceptions concerning African Americans have undercut their motivation and performance. However, part of my task for this study was to respect the different perspectives of preservice teachers in the same way as they viewed them. I look out for others working in the best interest of African American students. In the end, it is my hope that this complicated conversation about culturally relevant teaching helps increase our understanding of perceptions and its role in both students and teachers' success. As the educators, parents, and policymakers read this dissertation, I hope they will be informed about the issues surrounding teaching underserved students and contribute to improving the educational outcomes for all students, particularly underserved students.

Limitations

The researcher acknowledges the following limitations of the study. The limitations stem from the study type, methodologies, sample sizes, and reporting procedures. The goal of this case study is not to generalize the larger population but to learn from the findings. Instead the study offers insight into classroom activities that reflect greater knowledge of teaching underserved student mathematics. In qualitative research methods, generalization is not the claim. Stake (2010) argues that qualitative research is rooted in personal experiences and thus serves as a natural basis of what he calls naturalistic generalization. This type of generalization is described as a partially intuitive and empirical process arrived at by recognizing the similarities of issues and situations of context. Because a qualitative case study is dependent upon situated context, it is essential that the research analysis provides enough detail for users to understand their own situations.

This research does not claim generalization to the broad population, as is not the purpose of a case study. The findings represent the preservice teachers who participated in the study and are not intended to be generalized beyond the context of the current study. As with most case studies this size, there are no attempts to infer causality or relationships between the variables studied. According to Stake (1995), cases are not as strong a base for generalizing to a population of cases as other research designs. Thus, through case studies, we broaden our understanding of the complexities of teacher perceptions. Unlike quantitative research measures, qualitative research design does not claim objectivity but is an object of study as well as a product of inquiry (Creswell, 2007) that provides spaces for experiential knowledge and specific contexts for understanding and interpreting classroom instructions and events (Ladson-Billings, 1995a).

Context specific. Furthermore, as a qualitative research study, this research is subjective and specific to the context of a middle grade mathematics classroom and does not hold as its goal to generalize. This study is specific to the context of the middle grade school and the experiences of eight teacher participants. The simulated virtual classroom context and the PSTs' own experiences within the MASC coursework and teaching practice are meant to offer the reader a perspective of the situation explored in this study. At the same time, this case study provides limited information about how the teacher participants might teach mathematics and see culturally diverse learners in a real classroom. The study used qualitative research methods to gain insights into teacher candidates' perceptions of mathematics, culturally diverse students and teaching in an SVC environment.

Sample size. Due to the nature of case studies, this is a small-sample study, which means the findings cannot be generalized to other populations but can add to the framework to

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understand PSTs in teacher preparation. Similarly, its intent is that practical changes may be considered when providing educational training for teachers of diverse classrooms. The method of the study is analysis that is framed around understanding preservice teachers' development during their coursework and teaching practice teaching process. Thus, the goal is to understand preservice teachers' learning opportunities and teaching approaches that are appropriate for underserved students. The decision to use a purposeful, non-random sample of participants from their teacher preparation project limits the ability to generalize the study's findings. Limiting the scope of this study is the small sample of eight selected PSTs from two algebra problem-solving courses for a university-based teacher preparation development. Additionally, the study was conducted over a four-month period, limiting the timing and extended effects on the participants' future instructional practices in the classroom and further in-depth studies.

Another limitation of the study is that it was not possible to verify the information provided by teachers. While the findings are not generalizable, the research methodology is replicated in similar teacher preparation contexts. Yin (2003) suggests that a collective case study design uses logic of replication, in which the inquirer replicates the procedure for each case. The cases and the findings apply the knowledge that the readers gain from this study to existing knowledge of their own personal contexts and therefore develop a personal understanding. Focusing research questions on the teacher candidates' perceptions and approaches lead to the kind of understanding that is needed to improve practice. Thus, the results represent teachers' responses and not what was observed in the classes or otherwise verified by me. Nevertheless, this study does contribute to the existing body of literature that highlights the perceptions of algebra preservice teachers, specifically in their classroom practice with specific curriculum and pedagogical practices used in these settings.

Summary

In this chapter, I discussed a collective case study design within the social constructivist paradigm of qualitative research method as an appropriate tool to examine teacher learning in a simulated virtual classroom. I describe the study's approach to use a qualitative case study research design. I review the practices of qualitative research and case study research while providing examples of how they are applied in this study. I detail my primary data source and explain how this source supported my inquiry. I elaborate my analysis procedures to demonstrate how my findings emerged. Finally, I established the criteria for trustworthiness within qualitative research and explained how I maintain the criteria for trustworthiness within my study.

In the next chapter, I detail the results of my analysis and address my research questions. I describe how the structure of the SVC, and the experiences of PSTs provide the teacher candidates with opportunities to draw on a culturally relevant teaching practice. I describe how, as a result of the PSTs experiences in a SVC, they approach important aspects of diverse classroom life. I describe how the KATE structure of SVC supported teacher candidates and align closely with my teaching practices. I focus on a few of the classroom interactions that the PSTs planned and demonstrated and the extent of knowledge they learned about their teaching practices.

CHAPTER IV

FINDINGS

Introduction

In this chapter, I reported the findings that I generated from the analysis of the interview transcriptions. Participants' approaches in teaching culturally relevant lessons and their perceptions regarding their experiences teaching in a simulated virtual classroom in Second Life (SL), were the units of my analyses. The two research questions posed in the study that guided my analyses were:

(1) What are preservice teachers' approaches in teaching culturally relevant lessons during a problem-solving course?

(2) What are preservice teachers' perceptions regarding their teaching experiences in a simulated classroom in Second Life (SL)?

The present study was a part of the KATE Project that prepared preservice teachers (PSTs) with practice-based experiences in which they planned, implemented, and self-reflected in a culturally responsive way.

The six main themes that I generated from my analyses were:

1. Not confident in ability to plan culturally relevant lessons

2. Consider student perspective, make problems relatable to real life

3. Mimicked instructor/class lesson examples

4. Wanted more practice teaching time (and earlier)

5. Found SL teaching practices valuable but some technical limitations

6. Student engagement

In the following sections, I elaborated on the six themes by providing excerpts from the actual interviews conducted with the participants. The eight participants in this study were named as: Linda, Tori, Diana, Abby, Sofia, Rachal, Tanya, and Katy, all of which were pseudonymous. I first presented the within case analyses' findings referring to one of the two research questions. In each within case analysis, I presented the main theme(s) emerged from my analyses of the interviews conducted with the participant and illustrated the theme(s) providing excerpts from the interviews. After the findings from all eight cases were reported, I presented my findings from the cross-case analysis of the cases. In this section, I reported the similarities across cases.

Within-Case Analyses Findings

Introducing Linda

Linda identified herself as a Caucasian (European American) and Indian woman who had always loved teaching algebra. Linda explained how her approach focused on issues of culture and drew on students' background knowledge to support and engage their learning. She stated: "I did [the] culturally relevant [scheme]. I did ice cream. Everybody loves ice cream."

Five themes emerged in analyzing Linda's interview responses.

<u>Research Question 1</u>

Consider Student Perspective, Make Problems Relatable to Real Life

When it came to teaching her lesson, Linda affirmed that "many of us have never put down a lesson plan and it was cool being the teacher." She stated:

> I needed to realize that [teaching] is not something that you can plan out every single
>
> moment of the lesson. Most of it, you just need to put points and then follow with those
>
> points and let the class lead through the lesson.

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Linda realized that the process of lesson planning must also include the cultural perspective of students to encourage them to engage in learning. Linda said "It was frustrating at first because first, I made [the lesson] too simple; I didn't make it long enough."

Mimicked Instructor/Class Lesson Examples

At the beginning of the problem-solving course, the instructor provided culturally relevant lesson examples for the PSTs. One example described a family going out to dinner. Interestingly, several PSTs "mimicked" this "food" example in their lesson design. Illustratively, Linda's lesson topic was on food. Linda stated, "I did [a] culturally relevant [scheme]. It was a big deal to have them perfect."

Another theme that emerged from Linda's transcription analyses was "frustration." When Linda created her lesson plan, she struggled with her conception of students' ability and the extent to which the lesson she prepared was in adequate complexity. She reported that, "It was frustrating because first, I made [my lesson] too simple; I didn't make it long enough. And then I didn't know if it was going to be long enough."

<u>Research Question 2</u>

Wanted More Practice Teaching Time (and Earlier)

Another theme that emerged for Linda was that having more teaching time would have been helpful. Linda expressed that, "I did the linear equation, and then there at the very end, I wanted to explain graphs, and I had two minutes left." She noted that one thing she regretted was "I should have gotten – put the graphs in the beginning and explained those before going through the lesson. It was just hard putting all of that in only 20 minutes."

"I want to plan everything and it made me really realize that when it comes to being in the classroom, you can't plan every little step. You kind of have to go with the flow and have a

structure."

Found SL Teaching Practices Valuable but some Technical Limitations

Familiar with both SL and algebra, Linda had a positive experience teaching in SL on the one hand. She credits her past experience in SL along with her enthusiasm for teaching which reinforced her positive perception of her teaching practice:

I feel like I did [well], but that's because I've been playing Second Life for so long, like I understand it and understand how it works in a lot of different ways than we were just using it. Oh, I like just putting it together, getting the experience of doing it because obviously, many of us have never put down a lesson plan and it was cool being the teacher. I loved it because I have played Second Life since I was 13 years old. So, it was cool using it in a different way. And I liked being able to have the PowerPoint up in there and have the Smart Podium. It was fun. I just thought it was a really cool way to use Second Life. Yes, it was really cool, like a different way to use Second Life.

On the other hand, she had difficulty balancing her teaching activities for various reasons. She remained unfamiliar with the practical applications of SL in teaching stating that, "In regards to Second Life, it was hard to – be able to keep up with my lesson and the PowerPoint and still be able to see the whole classroom." Although Linda accepted the overall idea of using SL, Linda rejected the teaching realities of engaging in so many activities simultaneously. In a way, Linda believed that her efforts to create a balance prevented her from engaging her students: "it was frustrating balancing between everything. While I was trying to do something and forgot to do the mouse over here and then move it back from the Smart Podium to the computer." Finally, Linda positively indicated that most of the avatar students provided reinforcements and feedback that were realistic in her view: "I feel like they were. 'Cause kids will do that all the time. This is

hard."

Student Engagement

When asked whether she was able to engage with students, she expressed that, "I felt like it did, like it was different, but there's no way for us to be able to have an actual hands-on experience at the age and learning process that we're at in school." She continued, "I think it was a very valuable way to be able to do that without using students who are that age. I think it was cool." But then she revealed the differences between her perceptions and what actually happened when she watched her video: "I realized that there were a lot of hands – standing out there [in the classroom] the avatars are in the way, so you can't really see the people in the back of the room who have their hands raised ... So that was hard. And when I get nervous or anxious, I talk really fast. And that kind of messed it up."

Linda advises others that to improve their teaching, they need to, "Relax and don't freak out and engage the students more. I think that's one thing that I should have done more." Linda added that in her future teaching, instead of "does anybody have any questions?" or "Does that make sense?" I should have just picked someone and be like, "Hey, you answer this question." Finally, she admitted that she should have "Put the actual equations, the examples, in the beginning."

Introducing Tori

Tori understood the system of equations and felt that, "that's the thing I'd always remember from algebra, like I remember that from junior high specifically. That was something that I was really good at, so it was like oh, I got this." Tori believed in the teacher "knowing everything that you're teaching and being able to answer your students' questions." Tori saw her mathematics concept as culturally relevant because it was about going to the movies and she

added "at least from where I come from, most seventh - and eighth graders have been to the movies." She commented that "it probably won't be something you see on a test" In the end, Tori decided to do algebra at a lower level explaining her move that, "I'm going to be teaching kindergarten hopefully, so I won't have to do as much algebra."

Six themes emerged in analyzing Tori's interview responses.

<u>Research Question 1</u>

Not Confident in Ability to Plan Culturally Relevant Lessons

Tori was not confident that she created a culturally relevant problem for her teaching. Her perception was that:

> Yeah, I left a lot of _____ plan to –looking back I don't know if I actually did. But I left a lot of questions that I wanted the students to answer to, I guess, see how much they knew - so allowing them to give as much as they wanted to, or as little as they wanted to, and also asking questions. "So everyone has been to the movies; right?" Kind of things like that, so making sure that if it wasn't culturally relevant, we can make it culturally relevant and kind of twist it to have it do that.

Consider Student Perspective, Make Problems Relatable to Real Life

When Tori was asked about something that was an insight to her, she responded, "Yeah, probably like I guess not knowing your students' background before you make the problem kind of thing." Tori elaborated: So making problems more realistic for the students or from the aspect that they have seen.

Mimicked Instructor/Class Lesson Examples

For Tori, the task of selecting a topic lesson came from her experience within the MASC problem solving course. She elaborated,

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I think I just went back through our presentations in class and saw something and I was

like, okay, movie tickets, that's culturally relevant. That's kind of the easiest thing to pick

in my mind; it just popped in, it worked. And then the problem itself was just something I

could remember to do from algebra and I think we've gone over a problem like that in

class.

<u>Research Question 2</u>

Wanted More Practice Teaching Time (and Earlier)

Tori felt that she was "thrown into the - like I know we had a few minutes where we

came up here, we learned how to move those smart pony [Smart Podium] back and forth." But

after teaching, she expressed her concerns:

I think that I would - I'd probably spend a lot more time on it and make it - I'd probably

clarify a lot more in my - what I was actually speaking, not actually what was on my

slides, but when I was actually speaking, and not been so nervous, I think, to go into it.

Found SL Teaching Practices Valuable but some Technical Limitations

First, Tori pointed out that she has had some experience and added:

I've done online classes and stuff like that, but it really doesn't feel like an instructor

telling you what to do. It's just - it almost feels like a proctor just handing you your work

kind of stuff and you kind of figure it out on your own, because for me, I don't learn well

that way.

As a student, Tori struggled with online classes and with the fact that she might have preferred a

physical classroom to online environments. She indicated that:

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I have to be in the classroom, like having the paper in front of me, being able to write it

out, seeing as they're doing it, like doing it with the teacher kind of thing. And [in]

Second Life, there isn't really that option. That was really the hardest thing for me.

In addition, Tori saw her experience as valuable but complained about what she thought did not

work was "the [Smart] podium, like going back and forth. For me, the podium to the laptop, that

was really hard and it left a lot of pauses, I guess, in the teaching." Because of her feeling

toward the technical difficulties with the Smart Podium, Tori advised others to:

Not to get frustrated when there's technical difficulties. There's nothing anyone can do

about that. We are going to be using technology in our classrooms; there's just no way

around that, so you might as well learn your patience. Learn when you need to walk

away, learn when you need to go sit down, and have a blast of water, take a breath,

whatever.

Student Engagement

When asked whether she was able to communicate and engage others, Tori responded,

"That was great. That was easy. We didn't have any technical problems or anything. That was

fine – being able to talk back and forth to the students." But then Tori justified another reason by

pointing out that to some degree:

I didn't take it too seriously because I knew they weren't really middle-grade students, but

at the same time, you're like, well, I'm still getting graded for this, so I still want to do it –

I can play my part and they're playing theirs.

 Introducing Diana

Six themes emerged in analyzing Diana's interview responses.

Research Question 1

Not Confident in Ability to Plan Culturally Relevant Lessons

One of the main themes that emerged from Diana's interview analyses was that she was not confident in planning culturally relevant lessons. Diana explained how she prepared her lesson, "I did a culturally relevant problem. It was about a snow cone stand." But then she seemed to doubt her idea of culturally relevant teaching by stressing, "Honestly, I don't even know the difference – I know culturally relevant and I don't know the other ones." In her unfamiliarity with culturally relevant knowledge she stated, "If I had turned in my original one that would have just not been helpful at all."

Consider Student Perspective, Make Problems Relatable to Real Life

One of Diana's hallmarks of enhancing her teaching practice was to consider students' perspective. She explained how she gained insight by looking at different perspectives. Diana reflected that whenever students asked questions:

> Can I solve it this way? 'Cause it was – that's something that I hadn't thought of. And so then I was like, aha, maybe I should think of other ways to solve these – I was like, no, that doesn't work, but then when I went back later afterwards and thought about it, I was like, that totally worked and I told them that it didn't.

Diana recalled that a lot of the questions that the students asked totally caught her off guard, "I think misconceptions – we talked about those a lot in class – I think that those need to be considered more for my future experiences with this because –that was really tough for me."

Mimicked Instructor/Class Lesson Examples

In creating her lesson plan, Diana used her past experience explaining that "Actually, it was really easy for me because it's what we did in class – changed a few things – some of the problems that I had was like [the course instructor] wanted it to be harder."

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Wanted more Practice Teaching Time (and Earlier)

The first theme that emerged for research question two was that Diana had wished to have more practice time. Diana explained that, as she tried to teach, students' questions stood in her way. She elaborated, "It's things I didn't even consider" and "a lot of them I didn't even know the answer to and it's kind of like, you're timed and you want to be right, but you don't have time to process it." Diana's advice to other teachers was to, "Just to plan ahead better and spend more time on your lesson plans because I would put mine off kind of late and do it last minute and that was my downfall."

Found SL Teaching Practices Valuable but some Technical Limitations

In her teaching practice, Diana had this to say, "I really liked Second Life. I loved the – the Smart Board. That was probably the most helpful thing for me at least because I'm more of a visual person, so I have to write it out and draw it." Diana explained that since this was her first-time teaching, "It was really weird" but at the same time, "It was really cool." She added that "I got frustrated with myself because it was tough. It was really hard for me, but not really with Second Life." In addition, Diana believed that some students' questions and feedback were realistic, she reported that:

> I feel like in real life – 'cause for another one of my classes, I actually go to a school and stuff and I am physically there and so it's very different. In Second Life, it's like – I mean, you can walk around, but you can't see what they're doing and touch papers and write on it. And so, I liked that they talked back to you. I liked that you have real people and it's not all of the computers talking, but so it just kind of depends on the moment.

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Student Engagement

Another theme that emerged in analyzing Diana's interview conversations was that Diana's lesson lacked student engagement. In engaging students in specific relevant mathematics learning, Diana explained how she did not properly prepare answers to respond to students' questions. In the interviews, Diana said:

> Math, I think, is really hard to explain verbally, at least for me. So being able to write out formulas and piece things together and stuff because you can only do that so much with a PowerPoint, like that allows you to go outside of the original plan.

After teaching her lesson, Diana reflected on her interaction with the students such as:

> A lot of the time, I didn't notice hands going up because it's like you're looking at so many different things. And so, going back and watching my videos, like you ignored so and so at this point, and I'm like, I totally did and I didn't even notice."

Introducing Abby

Six themes emerged in analyzing Abby's interview responses.

<u>Research Question 1</u>

Not Confident in Ability to Plan Culturally Relevant Lessons

The first main theme that emerged in Abby's interview analyses was that Abby lacked self-efficacy in planning culturally relevant lessons. In the interviews, Abby told us what she intended to do and expressed that:

> It was kind of a nightmare. I didn't get any feedback on it. So that was kind of frustrating, and then she gave advice like, "Oh, make it culturally relevant. Make it so it's applicable to all students." So, I do it in the cafeteria, and she goes, "Oh, well that doesn't work for

all the students because there are some schools that don't have a cafeteria." And I was like, Okay, well my school does.

Consider Student Perspective, Make Problems Relatable to Real Life

Abby planned her problem-solving lesson with the assumption that students had some knowledge, and that knowledge was coming from the Texas State Standards, specifically the Texas Essential Knowledge and Skills (TEKs). She explained, "I went off TEKs and figured out what kind of information they needed to know." She extended her response by stating that "I talked to – [the course instructor] was like, well you know, you kind of have to prepare for students, especially in urban classrooms and stuff like that. They're not all going to be at the same learning level." Then she added that, "Maybe I would have asked what grade my students were going to be – maybe ask for more feedback. Maybe made it more of a point." In preventing future mistakes, Abby advised other teachers to "keep the questions limited. Keep them – kind of grow[ing] in difficulty, start very simple. She concluded that "make sure your students know the concepts you're about to teach – be prepared for students not to know.

Mimicked Instructor/Class Lesson Examples

Abby's interview analyses also revealed that she mimicked her instructor and used similar class examples in her lesson design regarding culturally relevant pedagogy. In the interview, Abby commented on her instructional approach. She reported that, "I did critical pedagogy [scheme], which is the one with the food – and she's like, "Oh, that'd be the best one." I was like, "Okay, but it's in Second Life, and they can't hold [it] – I can't give it to them."

Research Question 2

Wanted more Practice Teaching Time (and Earlier)

In the interview, Abby explained that she planned two mathematics questions for her lesson. The first question's scenario was held in a city where the data were collected. The second question was exactly the same except that its scenario was held in a city next to the local city. However, she was able to pose and discuss the first question only and there was not enough time for the second question. Abby wished that she had more time for practice teaching and that she was able to ask both of the questions she prepared that were designed to make the lesson contextual.

Found SL Teaching Practices Valuable but some Technical Limitations

Abby talked about her feelings of being in the classroom during the practice teaching experience as:

> Felt like I was kind of there. There were no distractions. I wasn't distracted. I didn't feel like my attention was being pulled. I was completely engaged in what I was doing, so I felt like I was there in that sense, but I didn't – it wasn't anything compared to being in an actual classroom.

Then she talked about her frustrations: "I mean I wouldn't say the teaching part was frustrating. But the planning and preparation." Furthermore, Abby's frustrations extended to technical difficulties that she acknowledged experiencing including these expressions:

> The lag killed me. They're like, "Oh, we'll write ahead of time." Okay, I did, but then I'd ask a question, and there'd be awkward silence. So, in real life – because I had teaching opportunities before just where I go and teach a class and kids are super quick. Like they're interrupting me to talk, whereas in Second Life, I had to wait, and it was to a point where sometimes I would just not even get my answer – you all understand? And

it'd just be silence. And I'd be like, "Okay, moving on," because I was timed. I needed all

the time I could get. "It was a little challenging" just because there was the lag, but I

could understand them, and I felt like they could understand me. So besides for them not

responding as quickly as I would have anticipated, communicating with them was fine.

Student Engagement

Although Abby planned her lesson with a goal in mind, she expressed distress after

teaching her lesson:

Well, I was a little confused. I don't know if I did it wrong, but none of the students knew

– or the majority didn't know how to do the problem." I went off the [TEKS] objectives,

so I felt like they should have known it – but they didn't. I had to ask like, "Do you all

understand?" Because there was time – one kid was like, "She's going too fast." So, I had

to go back and kind of explain.

Abby added:

My lesson was kind of struggling trying to figure out – because a lot of it was like, "Oh,

you don't understand this," and I had to guide – asking the students to articulate the

meaning behind a procedure, and asking a student why he did that. I couldn't do that

because the students didn't even know about it.

Based on her past experience, Abby remembered the advice about setting up problems to

engage students. She recalled being told:

You don't need all the information given. And so that's how I was going to engage them

by asking them questions – like how do we set this up, what information do we need?

Having them lead the lesson, but that backfired because I didn't know how to do it.

Introducing Sofia

Sofia reported her ethnicity as a Latina American which was different from the other participants. My analyses of Sofia's interview responses generated five main themes.

<u>Research Question 1</u>

Not Confident in Ability to Plan Culturally Relevant Lessons

Sofia was not confident in planning culturally relevant lessons. She mixed up culturally relevant lesson design and critical pedagogy. In the interviews, Sofia expressed that she did not plan a culturally relevant lesson. She said: "[the lesson I created] was not really culturally relevant." More specifically, she defined the cultural relevancy of a mathematics lesson as "Problems, like, that go towards what students live, like, their life experiences, I guess, that could relate to them." Then she gave her reasons by stating that "Well, part of it was because in – when we all did it together that was, like, as soon we said it the teacher was, like, "Oh, great, that's a good problem." That and I know middle school was when we started learning about graphs and slopes so I felt that fit well."

Then she iterated her instructor's comments as "[Sofia's instructor] said [Sofia's lesson] wasn't original and something but everything we did culturally-relevant in the class was food-based." Sofia recalls how she decided on the problem for her lesson:

> Well, we've talked about pizza all semester so that's what kinda threw me off so my second problem and the one that actually I went [with] was one we did in the classroom, my group did in the classroom. I told them, "Hey, well can I just use this question because I need a problem?" So that's how I got that problem, the second one.

When asked if she had a good understanding that culturally relevant teaching was an effective way to engage with students, Sofia responded, "It was. I ended up doing a critical

pedagogy [scheme] … That's the one I went with after all because it was a, like, voting so, yeah, it wasn't culturally relevant but critical pedagogy, it was a food drive." When asked, if she thought that she had a good understanding of what culturally relevant or critical pedagogy was or was not, Sofia responded that "we got a general idea of it but, like I said, since all the whole semester our culturally-relevance towards kids was food-based, it was okay – everybody eats, sure, but that's the only actual example that I feel we actually, like, got out of it. Sofia explained further that "That it's, like, problems, like, that go towards what students live, like, their life experiences, I guess, that could relate to them."

Consider Student Perspective, Make Problems Relatable to Real Life

Sofia thought that by selecting a food drive, she was making a connection with the students' lives. She explained her experience as:

It was a food-drive problem and I know in public areas, public schools, normally, I mean, growing up, I always did food drives in our schools so I figured they're gonna run into it, might as well do it now so they have a little bit of information on that.

According to Sofia:

The course taught you different things. I didn't know about culturally relevant and critical pedagogy and the actual activi[ties], like the ones in the classroom. I learned to open my eyes towards, like, make it more general and not just choose a[n] ethnicity. Make it broader, in general.

Mimicked Instructor/Class Lesson Examples

Another theme that emerged from the analyses was that Sofia mimicked her instructor and used the same class examples in her lesson. In creating her lesson plan for SL, Sofia initially stated: "My problem was about ice cream. Like a parent taking a child to get ice cream scoops

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and it's charged by-the-scoop and then you add per-topping, things like that." She explained that the feedback she had received was:

> Okay, create a new problem. This might not work as well. It's not really culturally
> relevant but everything we did culturally-relevant in the class was food-based. "Well,
> we've talked about pizza all semester" so that's what kinda threw me off so my second
> problem and the one that actually I went through with was one we did in the classroom,
> my group did in the classroom. I told 'em, "Hey, well can I just use this question because
> I need a problem?" So that's how I got that problem, the second one."

Finally, what Sophia ended up doing was critical pedagogy. As she explained, "That's the one I went with after all."

Research Question 2

Found SL Teaching Practices Valuable but some Technical Limitations

According to Sofia, what worked in her teaching best was the communication with the avatars in SL. What did not work well was the writing on the board. In the interview, Sofia complained that, "That was exhausting … A little too uncoordinated with what you write." Sofia stated that: "I prefer not to do Second Life. I am not a big fan of it. I mean it could be helpful towards certain people but I didn't feel it was all that great for some reason or another." Sofia concluded that, "No, I couldn't keep up with four things, the question marks, explanation points and then the board, the PowerPoint and then a chat, like, it's too much. In my opinion it was too much to keep up with."

In her teaching plan, Sofia explained that communication with other avatars in SL was fine, being able to hear and speak to avatars and have conversations with them worked, and the PowerPoint went well. However, writing on the board was exhausting. She clarified, "The

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writing on that board was not good – was exhausting? A little too uncoordinated with what you write." Sofia was satisfied that "other than the board, I mean, the communication, was well. Keeping up with the little exclamation points, question marks, that was a little ugh but other than that just the communicating part went well."

Sofia gave advice to others who might have been interested in teaching the same class. According to Sofia, they needed to "To relax. I know most of us were like, "Oh my God, we're next" or "Oh, we're teaching." It's like relax, you know?"

Student Engagement

Another theme that emerged was student engagement in the analyses of Sofia's interview. In preparing her lesson to engage the avatar students in practical applications using culturally relevant teaching practices, Sofia responded:

> I did give a little bit of feedback, not everybody [gave] feedback but, for the most part, I was able to be like, "Can you read this for me" or "Good job, what did you get from this problem, what do we know, what can we do next," you know? I was asking questions to the children.

According to Sofia, how she tried to engage the students depended on not including all the information. She gave details as:

> My PowerPoint purposely – did not have all the information so I could ask them questions and then, on the board, I was planning to write it out while they were talking, so, like, on my PowerPoint, I put, "What's next?" I put, "Hint: Gave him a table," so x and y "so what's our x, what's our y?" Not literally [write] every number in there. That way I could talk with them and they know what goes where and why so that's how I planned out to actually communicate with them."

Sofia agreed that she had engaged students during her teaching but clarified by making a comparison of engaging students in a virtual classroom and in an actual classroom by stating that:

Last semester we actually went into the elementary classrooms so you see that it's a huge difference, like after my teaching-plan lesson I was told I didn't pay attention too much to the kids, that I ignored about two children or students and it's, like, well, I know in real life you're actually gonna see them. In Second Life it's kinda difficult – to see your kids, see that PowerPoint's working and see whatever you're writing on. It's kinda hard to see, "Oh, somebody has a question" but when you're in an actual classroom, you're writing and everybody's communicating with you, you get to see your own classroom – So, it's just a lot more difficult to actually keep up with communicating and collaborating with students on Second Life.

When asked if the questions avatar students asked were realistic or not, Sofia's opinion was mixed. She reported that:

Some questions yes. Some, the silly questions, okay, yeah, I could see a middle-grade student asking that, being silly or just – it was taken a little overboard with the silly questions, you know what I mean? There were too many, like, just trying to throw you out of your question, like, "Oh, well my mom says this and I don't do that. It's like I don't think I ever experienced all those types of questions when I was in middle school so I think that was a little bit overboard. Other than that, they would ask you, like, "Oh, I don't understand this." Okay, yeah, I could see a student asking me that, so.

Introducing Rachal

Four themes emerged in analyzing Rachal's interview responses. Rachal's interview analyses revealed that she decided to go with the critical pedagogy scheme in her lesson design.

<u>Research Question 1</u>

Consider Student Perspective, Make Problems Relatable to Real Life

Rachal made a point to consider the students' perspective and to make the problems relatable to real life, she employed the approach of:

> Coming up with questions to ask, like I had a paper next to me and kind of checking off some questions like what do you think? What happened? Like I think at the end of my lesson a student had asked me "Well will prices increase?" and I was like "That's a good question. What do you think is going to happen?" and it kind of gets them thinking and because it was gas prices it's kind of relevant to them. I mean I'm sure they've heard their parents complain about it. I know I have so they could – it's real life to them. It's real and it gets them thinking for the future like "Hey. I wonder what gas prices are going to be like when I drive a car."

Although Rachal considered students' perspectives in her teaching, she also explained what she learned from others' teaching. She reported:

> I really learned that you're just going to have to go with whatever the students ask because I was running through my lesson plan ahead of time in my head and I was like "Oh well this should go by pretty quickly" and then I get in there and they're asking random questions that sometimes don't deal with the math problem and then questions that I probably should have been more prepared to answer and wasn't.

I think watching the other students. It helped to see how they got their students back on

topic and stuff like that because I knew going in there that they were going to ask

questions, random questions and stuff but I could kind of recall what my previous, the

previous teachers had done to get them back on topic and I feel like that helped.

Mimicked Instructor/Class Lesson Examples

Rachal reported that she also mimicked the instructor when it came to designing

culturally relevant teaching practices. Rachal said:

It was kind of something I thought we were going – we went over in class a problem like

the one I came up with. Then [instructor] said it probably needed to be more culturally

relevant. She felt like maybe it was too juvenile or not quite up to the grade level that she

wanted so I had to come up with a new one and so I guess – I don't know. I felt like the

problem was ok that I first came up with just because it was stuff we were doing in class

and that's how I knew what to choose and then getting that feedback back was a little

shocking at first but then it also helped me realize well I mean there's so many other

things I can do with problem posing and really got me to work on using problem posing

in a different way.

Research Question 2

Wanted more Practice Teaching Time (and Earlier)

Rachal was more able to engage effectively in managing her time than the other

participants. However, she reported that she could have used the time to generate better slides.

She said:

Probably set up my slide show a lot different or the Power Point. I feel like I just used

the first two slides even though there were like eight so definitely use the tools that I have

to my advantage more than I had before.

Found SL Teaching Practices Valuable but some Technical Limitations

On one hand Rachal felt that the technology was easy to use. However, she reported

some technical limitations to the technology. She explained:

I really liked how they could type it in too. That was cool. The voices were creepy

sometimes but yeah. I felt like I could engage. The students could ask me questions

directly and I could hear them in their voice. Hearing them you can actually tell like in

the pitches of their voice if they're frustrated and then you need to just take a step back

and kind of [re]iterate what you were just saying so I felt like that was really interesting.

Another thing that Rachal liked and found valuable in SL was:

I really liked the bubbles that would pop up with the green light that they were good,

yellow question marks that they were kind of confused and red they just didn't get it at all

'cause it showed me what I needed to go over and some stuff that I could just kind of

keep going.

Rachal added that preparing and being able to answer students' questions and "getting

them back on the right track to the math problem was really helpful to see in a virtual classroom

rather than just throwing me into an actual classroom and dealing with it in a real-life situation."

On the other hand, what did not work for Rachal were the following situations as she portrayed:

The [S]mart board thing that we wrote on, it lagged a lot of time between writing it on the

board and actually it showing up in Second Life. The writing tablet just because I was

running short on time as it was and then on top of that it's just not natural for me to write

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first and then wait like a couple seconds and then talk about what I just wrote. Instead

it's easier for me to talk as I write and I've seen that's kind of what all my professors do

so I think that was the one thing especially 'cause I was running late on time. I was trying

to write it all down really fast and go through it as quickly as possible so I could hit all of

those points and I just had to wait. I was like "Ok guys. Hold on" and then there was

just a lag in the conversation and I feel like in a real-life situation a lag in the lecture or

the conversation really kind of lets the students lose focus of what task is at hand.

I felt it was more like because of the technology there was kind of a barrier like when I

started talking to a student I was like "Do you have a question?" and there was just that

lag and silence and I was like "Is anybody out there?" and then also you'd have the issue

of two people talking at the same time 'cause there's not that face to face reaction where

you can see if somebody's about to say something and also with the writing technology

so it's like "Ok. Hold on guys." And I would always forget to start writing ahead of time

and then talking 'cause it's just natural to talk and write at the same time.

Student Engagement

Student engagement emerged as one of the main themes in Rachal's interview analysis.

Rachal left a lot of room for her students to get engaged with the lesson. Rachal reported:

What worked was I based mine off of a graph and I feel like it was very visual for the

students and it wasn't sitting there and reading a huge paragraph for the problem and they

could actually see what they were working with. I know I asked them like minimum,

maximum so basically just taking the information on the graph and kind of introducing

new definitions or like maximum, minimum some of them had never heard before and

then the average or I put it in a new term 'cause I had learned it at first as the mean and a

lot of them didn't know, didn't understand what mean was and so then I said "Well does

anybody know what average was?" and a lot of people were like "Yeah. I do." I said

"Well mean is another word for average."

Rachal looked at students' questions and feedback as being realistic explaining it this way:

I think so. I mean students especially in younger grades tend to be a little, they want to

make it interesting so they'll ask questions that might throw the teacher off guard and I

know I was thrown off guard by some of the questions so it was – it was a good

experience to have because I need to not get – I get when a kid asks me a question that

pertains [to] nothing[that I said] – but anyways when a student asks me a question that

deals [with] nothing with the topic I feel like "How can I get them back on topic?" and I

feel like by having this then I can maybe get more practice in and like Oh yeah. That's

cool but yeah. Let's go back to the question real fast and I can answer your question after

class if you want to talk about it some more.

Introducing Tanya

Five themes emerged in analyzing Tanya's interview responses. They are noted as

follows.

<u>Research Question 1</u>

Not Confident in Ability to Plan Culturally Relevant Lessons

Tanya was moderately confident in her ability to plan culturally relevant lessons. In

creating her mathematics problem for the teaching practice in SL, Tanya reported that, "I did

critical pedagogue [scheme], but I made sure that it was culturally relevant, too. That way, the

students weren't like, I don't understand this, because that way, they all can have an equal time

learning."

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Consider Student Perspective, Make Problems Relatable to Real Life

Tanya believed that students should experience mathematics that was more challenging. She illustrated her view as:

> Yes, there were a couple times when the students would ask like, "Can you simplify this number?" And I'm like, "I don't think so," and then I have to do the math by myself, and I'm like, "Oh, you can." So, going through and making sure that you know different ways and different tricks that students are going to try to make the problem simpler. Definitely, I didn't even think about any of that, so definitely going back and making sure I know all ways to do the problem. When they ask weird questions, like, "Can you simplify this, or can you do it backwards," that I should know the answer and not have to be like, "Oh, let me double check that really quick."

Tanya picked a lesson that she thought was relevant to the students' lives. She explains her lesson as:

> It was proportions over A&M doing the fundraiser to buy Christmas presents for the underprivileged kids in [Brazos] County. I feel like students at their age should know how to do proportions, be able to do that math quickly. I mean it's important because they're going to see proportions all throughout their lives, and it's nice to know the both ways to do it, the multiplication and the proportion ways. Something that all students, no matter what their status is, can relate to something and a question that they should know how to do but not fully know how to do, and figure out the questions I thought they would ask me so I'd be able to answer them in my teaching, and then the questions that they did ask me, I was prepared for those, too. So, it's not like going to Disney World, but it's like going to the store with your family because all kids can relate to that.

Wanted more Practice Teaching Time (and Earlier)

Another theme that emerged was that Tanya wished to have more practice teaching time. Consistent with Tanya's knowledge of her teaching practice, in the interview, Tanya reported: "having a little bit longer time to teach in the lesson because I didn't really get to everything I wanted to get to because I kind of had to stop mid-through."

Found SL Teaching Practices Valuable but some Technical Limitations

Tanya found the SL teaching practices valuable with some limitations of technology. Tanya referred to her participation in SL as, "I thought it was fun. I mean I want to be a teacher, so getting to create something that I was actually going to be able to teach about was fun." Tanya further expressed her feelings stating that:

> I felt like I was actually in the classroom physically with the students and not sitting at a
> computer screen talking to them. So that was kind of cool. I was really nervous about
> that whole thing about not being there, but you actually feel like you're there. I mean at
> first, you kind of feel like you're just talking to the class, but once the students start
> asking you questions, you kind of feel like you're actually in the classroom, and then I
> felt like I was there until they told me my time was up, and it was just like kind of like
> you blink, and you realize that you're not – it was like when you read a book, you picture
> yourself in the book with the characters. But then when the book ends, you're like, "Oh,
> I wasn't ever really there ... So, it was cool.

Tanya also reported that everything worked for her except the "lag" and the part where she did not know who was talking. She said:

Okay, what did you say, yes? Who has their hand raised? As a future teacher, she should have been able to communicate with students, "So and so, good job. Bill, good job … Good questions." And then not being able to understand or me not being able to see who it is. It's kind of like just frustrated me a little bit, but nothing super frustrating.

Another problem was Tanya's attempts to write, "[Writing] was a problem because if you wanted to write something out, you'd have to write it out before you said it, but if you didn't know you were going to say it, you couldn't write it out." Another thing she had a problem with was that:

When you're trying to figure out who said what question, all the names are stacked. The students that are closest to you, they're fine because they're all spread out, but like in the back kind of in the corner, they were all stacked. So, it was hard for me being like, "Yes, so and so." It was just like, "Yes, what did you say," and not really getting to address the student with the name. So that was just hard.

Student Engagement

Student engagement emerged as another theme in Tanya's interview analyses. Tanya believed that she was able to engage students in her lesson as she stated:

Yes, definitely. They ask a question, then I was able to explain things – I had to know that I actually understood the problem, and not just like, "Oh, this is easy. I can just teach this," but I actually had to understand what I was actually teaching and how to answer their questions so they wouldn't be like, "What?"

Tanya made it a point to extend her lesson to engage with students but then, there was a limited number of slides, she explained, "I'd have to put everything on one side. So, I'd ask them

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the question, and they would know the answer because they'd see it on the slide, and it wasn't really them learning the material." Tanya explained that her expectations were met because:

> A lot of the trying to figure out the questions that you thought the students were going to ask was kind of hard, but it really helped in the end because they asked those questions — So that was kind of cool to kind of see it all come into play.

Introducing Katy

Six themes emerged in analyzing Katy's interview responses. Each will be discussed in this section.

<u>Research Question 1</u>

Not Confident in Ability to Plan Culturally Relevant Lessons

Katy was moderately confident in her ability to plan culturally relevant lessons. In creating her problem for SL, Katy shared that, I think I just had an idea of a concept I wanted to use, So I used a Venn diagram and I just wanted to base a problem around that and so I just googled something and looked for a lesson plan and then based it off of that. But then she shared that' "I think, if anything, I would just come in more to speak with Dr. "E" and the other professors in getting their advice in planning my lesson plan and my slides and advice in teaching in the classroom."

Consider Student Perspective, Make Problems Relatable to Real Life

Katy believed that she engaged students' knowledge in her plan, "I just make sure it was based around something that would be interesting to them. You just want to make sure that you can grab their attention and keep it throughout the whole problem and not make the steps to finding the solution too difficult."

Mimicked Instructor/Class Lesson Examples

Katy mimicked her instructor's class example when she designed her culturally relevant lesson. Katy declared that what she thought about was. "I think – I believe so. It had to do with ice cream and so at the end, students were like, Yeah, I like ice cream." In addition, Katy advises preservice teachers who will engage in practice teaching:

> To relax because that's what I needed, but I tell them to be confident in themselves and make sure they've prepared and gone over their lessons enough beforehand so that they're confident in answering students' questions and just preparing the lesson as a whole.

Research Question 2

Wanted more Practice Teaching Time (and Earlier)

Katy's reflections on her lesson were expressed thusly, "I feel like if I would have more time to finish my problem – I had an extension where we would take the poll in our class and so it would allow the students to give their opinion and see things like that."

Further, Katy explained that engaging in more practice in the virtual classroom would reinforce the experiences of teaching with students, she explained:

> I think enough of us are familiar with technology and similar programs, such as Second Life, I guess, that we felt like we didn't need it. It was all very helpful. It was very easy to work with. And I think it all led up to being successful in our plan. I do wish that we would have had another opportunity to maybe use our slides in Second Life and teach to our peers, like to our group, our table. I think that would have been helpful just so we can get a better analysis of where we want to be positioned in the classroom and being able to see all the students raising hands and looking at the question marks and things like that.

Found SL Teaching Practices Valuable but some Technical Limitations

Katy found SL very effective and easy to work with, yet it included some limitations. She expressed her feelings stating that:

I liked Second Life. It was very easy to work with. Just kind of visualizing the students, just being able to see their avatar, and seeing just even green symbols of them speaking, just adds to it, I think. One thing that was difficult was not being able to point at the board. And I think as teachers, a lot of – or future teachers, a lot of us like to use our hands when we talk and teach and I think that's kind of hard to sit there just behind a computer screen and know that your students can only see an avatar, but it worked well being able to see students raise their hands and have their identification above them and the different colored question marks, just know whether they're understanding or not because you don't get that in real life.

A final reflection by Katy was revealing and worth noting in terms of her experiences in the overall problem-solving course:

I think at the beginning of the semester when we did problem sets and things like that, I was very frustrated with some of those problems because they were difficult because it was something I'd never seen before. Going in and asking for help was exactly what I needed and I would do it again even though I was frustrated a lot during the semester with it honestly just because it was things I hadn't seen before and so I didn't know how to do them and that made me upset. But I appreciate the experience from it.

Cross-Case Analysis Findings

In this section I presented the findings of my analyses for all cases together. I provided additional excerpts from the in-depth interview transcripts as appropriate. Even though the

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themes presented appear across all the data, I refer back to particular examples when it serves to improve readability of the cross-case analysis.

I presented the findings in this section organized around the research questions and six themes. The first question was answered through the three main themes: (1) not confident in ability to plan culturally relevant lessons, (2) consider student perspective, make problems relatable to real life, and (3) mimicked instructor/class lesson examples. The second question was answered through the remaining three themes: (4) wanted more practice teaching time (and earlier), (5) found SL teaching practices valuable but some technical limitations, and (6) student engagement. Table 3 below denotes a summary of themes that each participant shared.

Cross-Case Themes	Linda	Tori	Diana	Abby	Sofia	Rachal	Tanya	Katy
Theme 1: Not confident in ability to plan culturally relevant lessons		✓	✓	✓	✓		✓	✓
Theme 2: Consider student perspective, make problems relatable to real life	✓	✓	✓	✓	✓	✓	✓	✓
Theme 3: Mimicked instructor/class lesson examples	✓	✓	✓	✓	✓	✓		✓

Cross-Case Themes	Linda	Tori	Diana	Abby	Sofia	Rachal	Tanya	Katy
Theme 4: Wanted more practice teaching time (and earlier)	✓	✓		✓		✓	✓	✓
Theme 5: Found SL teaching practices valuable but some technical limitations	✓	✓	✓	✓	✓	✓	✓	✓
Theme 6: Student Engagement	✓	✓	✓	✓	✓	✓	✓	

Table 3: Summary of PST Cross-Case Themes

<u>Research Question 1</u>

Not Confident in Ability to Plan Culturally Relevant Lessons

Overall participants were not always able to confidently plan and deliver a culturally relevant mathematics lesson in a simulated virtual classroom environment (SL). In particular, Tori and Diana did not feel confident with their capability to teach culturally relevant lessons. Abby also expressed her frustrations, saying that the experience was a nightmare. She tried to use the example of a school cafeteria but found it not relevant to all students. Sofia expressed that using a food-based example as a culturally relevant topic was effective, but she had to make several changes of her topic. For her topic, Rachal used graphs, Tanya used critical pedagogy

and Katy used Venn diagrams. Several of the PSTs had difficulty with developing culturally relevant lessons. This theme was evidenced in six of the eight cases (see Table 3).

Consider Student Perspective, Make Problems Relatable to Real Life

Linda and Tori emphasized the importance of considering students' perspectives when designing culturally relevant lessons. They said that it was important to use topics that many students could relate to in their personal lives. They also mentioned that it was important to know the students' backgrounds as a guide to developing lesson plans. Diana discussed how students gave her different questions about the same topics. She realized how important it was to view the same question from different perspectives. Like Diana, Abby created her teaching plan in a one-dimensional view. She designed her lesson by first considering the TEKS standards. However, she realized that she learned to ask questions and get feedback from her students. Sofia and Rachal made a point of including the students' perspectives and personal experiences in their teaching. Katy knew that she needed to incorporate the students' knowledge and grab their attention by making the material interesting.

Mimicked Instructor/Class Lesson Examples

The common thinking among several PSTs was to use culturally relevant topics that were based on the familiar or their personal experiences. As noted earlier, at the beginning of the problem-solving course, the instructor provided a culturally relevant lesson example for the PSTs that was in a dining or food context. Notably, several PSTs "mimicked" this "food" example in their lesson design. Linda, Sofia, and Katy discussed ice cream in their lessons because they believed and stated that "everybody liked ice cream" and so it should be culturally relevant to all. Diana mentioned a snow cone stand in her example. Abby saw food as being a good focus as well. Tori talked about going to the movie theater because she believed that all young people

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have gone to the movies. Tanya's culturally relevant topic was initially within a school cafeteria setting. She believed that most students were familiar with the cafeteria and lunchtime; however, she had doubts, considering the possibility that some schools did not have cafeterias.

Research Question 2

Wanted more Practice Teaching Time (and Earlier)

Some of the PSTs commented about wanting more time to practice their teaching skills in the virtual classroom in Second Life. Linda said that she wanted more time to plan her math lessons, but she also said that teachers should have learned to go with the flow and make the best use of the time they had. Tori said she wished she had more time to prepare what she planned to say before the slides appeared on screen. Diana reflected that perhaps planning at the last minute was also an issue. She also said that students ask a lot of questions that can throw the teacher off and make the lessons longer than usual. Rachal commented that she had enough time but wished that she had planned her PowerPoint slides better in advance.

Found SL Teaching Practices Valuable but some Technical Limitations

Linda mentioned she enjoyed using Second Life while teaching and had a positive experience. However, she had a few problems navigating between her lesson design and the virtual technology. On one hand most students liked SL. On the other hand, Tori had her doubts about online classes [or online technologies]. She said that the interactions between the students and the teacher were too distant in the online and simulated learning environment. She said that she never learned well using that method. Diana loved the Second Life experience and enjoyed using the interactive Smart Podium device. She believed that the students' questions and feedback were realistic, and she had no complaints about not being able to touch the students or see their work up close. Abby had both good and bad moments with SL. She mentioned the lag

that made it difficult for her to answer questions quickly and within an allocated amount of time.

Likewise, Sofia did not have good experiences with SL. She did not like using the Smart Podium device, the PowerPoint slides and the chat function in the SL classroom. Additionally, Sofia didn't find the student avatars' question mark and exclamation point gestures helpful. She felt navigating between the various tools was overwhelming and too much to handle. Rachal enjoyed preparing in the virtual classroom. She liked hearing the students' real voices and seeing the bubble [question mark and exclamation point gestures] pop up with their questions. Like Abby, she did not like the time lag that occurred after students asked questions. She did not find it natural or realistic to wait for a question while working on a timed schedule. Tanya has had a good experience working in SL, but she was not pleased with the few second time lag when using the Smart Podium device to work out math problems. Similarly, Katy liked teaching in the virtual Second Life classroom. She found the technology to be easy to use and interesting with its use of pop-up gestures and symbols. However, she expressed the difficulty of sitting behind a computer screen instead of interacting in front of the class.

Student Engagement

Linda expressed doubts about her own abilities to teach well and felt nervous in the beginning. She emphasized the importance of relaxing and calling on students more to answer questions. In contrast, Tori said it was easy to communicate with the students and get them engaged. She said SL was easy to work with, but she didn't take it seriously at first. Diana mentioned that she did not prepare her questions and answers properly. However, she believed that teaching math verbally is not easy, especially when working in a virtual classroom. She felt confident in her abilities to engage students, but she felt some limitations with the technology. Abby planned her lessons based on the TEKS standards. She thought that students would

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understand well but found that many did not. She realized that she should not have given students too much information at first. Her goal for the future will be to ask more questions to better engage students.

Sofia also found it helpful to ask students questions, talk to the students directly as she showed them the slides. Rachal used visualizations like graphs to engage her students. She also introduced new terms and definitions that they'd never heard of before. Tanya engaged her students by asking them questions and extending her lessons. In Table 3, the common themes across the cases were presented.

Summary

In summary, all of the participants made comments regarding themes two and five. They felt that it was important to consider student perspective or make problems relatable to real life. In addition, (See Table 3), all participants found that SL teaching practices were valuable, but some had technical limitations. While seven of the eight noted theme 3, mimicked instructor/class lesson and theme 6, student engagement. Six of the eight participants made comments about theme 4, wanted more practice teaching time and earlier and theme 1, felt not confident in their ability to plan culturally relevant lessons.

CHAPTER V

CONCLUSIONS

Introduction

In this chapter, I summarized and discussed the findings and made connections to the extant literature based on each of the research questions. I continued this chapter with implications for practice, recommendations and finally concluding thoughts. The chapter was organized around the two research questions that guided the present inquiry.

The KATE research team endeavored to redesign a mathematics problem solving course to provide opportunities for preservice teachers to practice creating and implementing culturally relevant lessons for middle school learners. The research team utilized a simulated virtual classroom environment in Second Life for the PSTs' practice teaching experiences. The current inquiry was designed to capture and document PSTs' approaches in teaching culturally relevant lessons for the first time. I also sought to learn about their lived experiences teaching the lessons in a simulated virtual classroom.

Discussion of Findings

Findings from the current study revealed the necessity for providing opportunities for preservice mathematics teachers to design culturally relevant lessons. Six themes emerged from the cross-case analyses of the eight cases: 1) not confident in ability to plan culturally relevant lessons, 2) consider student perspective, make problems relatable to real life, 3) mimicked instructor/class lesson examples, 4) wanted more practice teaching time (and earlier), 5) found SL teaching practices valuable but some technical limitations, and 6) student engagement. These themes provide several insights.

What are preservice teachers' approaches in teaching culturally relevant lessons during a problem-solving course?

Not Confident in Ability to Plan Culturally Relevant Lessons

Preservice teachers enrolled in a mathematics problem solving course were tasked with planning and teaching a culturally relevant lesson. 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 et al., 2011). The PSTs chose one of three strategies (or schemes) from the HLT to guide the design of <u>culturally relevant</u> problem solving lessons in SL: 1) Cultural Relevance - Use contexts for activities that are based in and relevant to students' cultures and lives; 2) Situated Learning – Provide an instructional context that allows students to have concrete and hands-on experiences with math knowledge and skills; and build math learning on realistic, open-ended, culturally relevant problems that students solve using a variety of skills, concepts, and tools; and 3) Critical Pedagogy – Provide learning activities in which students investigate the sources of mathematical knowledge, identify social problems and plausible solutions, and react to social injustices.

Four of the eight preservice teachers, Linda, Tori, Diana, and Katy, used the culturally relevant scheme to guide the design of their lessons. Four preservice teachers used the critical pedagogy scheme to guide their lesson design, Rachal, Tanya, Abby, and Sofia. Notably, Sofia revealed in her interview that she was not clear on the distinction between the culturally relevant scheme and the critical pedagogy scheme as she reflected on her lesson design.

In general, irrespective of the scheme that was used to design lessons that were culturally relevant, the findings suggested that several PSTs struggled with this. Illustratively, Tori and

Diana were not confident with their abilities to plan and teach culturally relevant lessons. For example, Tori expressed relief that, "I'm going to be teaching kindergarten hopefully; so, I won't have to do as much algebra." Diana was not sure whether she did or not stating that, "Honestly, I don't even know the difference – I know culturally relevant and I don't know the other ones." But in terms of teacher confidence in ability to plan culturally relevant lessons, Katy had the most difficulties. Katy stated, "So I used a Venn diagram and I just wanted to base a problem around that and so I just googled something and looked for a lesson plan and then based it off of that." Katy confirmed, "I was very frustrated with some of those problems because they were difficult because it was something I'd never seen before." The findings from the current study suggested that more work needs to be done in engaging preservice teachers in identifying effective culturally relevant lessons, and even more critical, designing them. This is consistent with what (Harel & Sowder, 2007) expressed that for many PSTs, the sense of self as a confident teacher of mathematics was difficult to obtain because of teaching anxiety (Harel & Sowder, 2007). This is inconsistent with learning strategies for increasing student understanding (Brown et al., 2012), which in turn promotes teacher confidence in enacting culturally relevant pedagogical beliefs.

Consider Student Perspective, Make Problems Relatable to Real Life

In planning lessons, it was evident that PSTs made attempts to connect algebra learning to students' perceived interests. Based on their understanding of culturally relevant teaching, Sofia and Rachal made it a point to include students' perspectives in their planning and teaching lessons and had some general concept of CRT knowledge but not the invisible life experiences of students outside the classroom. First, Linda, Tori, Diana, and Katy reduced culturally relevant topics to visible aspects of culture, such as food and entertainment to draw upon students'

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individual experiences and community backgrounds. For example, in her teaching plan, Tori commented:

> I mean, I'm all for telling them this is what happens, so we're going to do a problem so one day you can start your own fundraiser and you will know how to do it kind of thing. So, after all, we're supposed to teach you everything; right?

Tori's topic summarizes most of the PSTs' reasoning for considering students' perspectives. This perspective of PSTs is what Nelson and Guerra (2013) found in their research of PSTs that they will address only the visible elements of culture (food, ceremonies, language, music etc.) and overlook the less obvious elements, such as beliefs, values, and behaviors in their instructional approaches. This is consistent with literature from Gay (2010) which acknowledges that planning is difficult for PSTs because they lack the cultural knowledge base required in contrast to experienced teachers. In Ladson-Billings' (1994, 1995, 2014) studies, pedagogy content empowers students socially, intellectually, and politically. As students gained academic success, they simultaneously gained understanding of their roles in their communities. This is consistent with what the study's findings of Ukpokodu (2011) revealed that "teachers' critical consciousness, advocacy, and activism" (p. 54) and other elements of culturally responsive mathematics teaching were lacking.

On the other hand, the findings showed that Sofia, Rachal, Tanya, and Abby all drew from the critical pedagogy scheme to design lessons that were culturally relevant, this was promising. Rather than plan lessons in isolation, they embed their algebra topics within community contexts. For example, Sofia used a community food drive to write her questions. Sofia wanted students to become aware of the issues in their community. She explained how she knows "in public areas, public schools, normally, I mean, growing up, I always did food drives

in our schools so I figured they're gonna run into it, might as well do it so now they have a little

bit of information on that." Abby reinforced that fundraising is something that students have seen

before in real-life situations that connect with them. She explained the importance of modeling

problems that are realistic for the students or from the aspect that they have seen. Another

example of critical pedagogy was when Rachal tried to consider students using gas prices and

posing questions in a progressive way. Reflecting on her teaching, Rachal explained further:

> Coming up with questions to ask, like I had a paper next to me and kind of checking off
>
> some questions like what do you think? What happened? Like I think at the end of my
>
> lesson a student had asked me "Well will prices increase?" and I was like "That's a good
>
> question. What do you think is going to happen?" and it kind of gets them thinking and
>
> because it was gas prices it's kind of relevant to them. I mean I'm sure they've heard
>
> their parents complain about it. I know I have so they could – it's real life to them. It's
>
> real and it gets them thinking for the future like Hey. I wonder what gas prices are going
>
> to be like when I drive a car.

This is consistent with what Gay (2010) explained that teacher development allows PSTs

to plan meaningful interactions for themselves, students, and their environment, which is what

Ladson-Billings (1995b) calls "critical pedagogy." Making problems related to students is what

Ladson-Billings (2009) identified as thinking of the learner's interests.

Mimicked Instructor/Class Lesson Examples

Most of the PSTs learned how to plan their lessons by modifying or adapting the

curriculum their instructors demonstrated. Food was a major theme for most of the PSTs. Sofia

justified her first problem of ice cream, but then was encouraged to work on her lesson focus

more. Sofia elaborated: "Well, we've talked about pizza all semester." Similarly, she explained choosing her second problem and stated:

> The one that actually I went through with was one we did in the classroom; my group did in the classroom. I told 'em, "Hey, well can I just use this question because I need a problem?" So that's how I got that problem, the second one.

Diana added that prior to creating her problem, they were asked to come up with a problem in their group. Then she stressed:

> Actually, it was really easy for me because it's what we did in class – well, it wasn't what we did in class, but he had asked us a couple of weeks before to come up with a problem in our group and so we worked on it together. And then I just kind of used it and changed a few things. So, for me, it was pretty easy, but I think a lot of – some of the problems that I had was like he wanted it to be harder.

Research from (Gay, 2010) points to the fact that most PSTs are unable to create a culturally relevant lesson on their own. This is also consistent with what Guillaume and Kirtman (2010) found that PSTs seem to favor approaches to teaching that they experienced as learners, they tend to teach the ways they were taught. The findings suggested that the PSTs lesson foci did not capture the interests and experiences of their diverse students. Perhaps part of the issue is that as teacher educators engage preservice teachers in the design of culturally relevant lessons, a preliminary step must be to engage them in learning more about students' cultures and interests. This is a point that I will return to.

Three of the preservice teachers, Abby, Tanya, and Katy drew from TEKs standards or utilized a Google search to find something specific that works well with the students and something they could explain if questioned. Abby commented that "I went off TEKs and figured

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out what kind of information they need to know or was learning and stuff like that." Their actions are in accordance with Kennedy's (1999) findings that PSTs' decisions are influenced by their frames of reference and past experiences when unfamiliar practices became difficult to enact. However, this finding is inconsistent with what Gay (2009) has argued for cultural instructional resources need to supplement textbook topics to make it relevant to students and engage them in instructional reasoning, similar to Lipka et al. (2009) research of restructured mathematics knowledge in a social cultural context. It is also inconsistent with what Ladson-Billings (1995b) asked, that teachers not rely solely on the state curriculum to decide what to teach; teachers stop using "traditional instruction conventions" (p. 27) and modify the curriculum to reflect the cultural styles of students.

What are preservice teachers' perceptions regarding their teaching experiences in a simulated classroom in Second Life?

Wanted More Practice Teaching Time (And Earlier)

Diana complained that she did not have 'time to process" a lot of the questions that avatar students were asking her and in addition, she did not know the answer to them. She expressed that "it's kind of like, you're timed and you want to be right, but you don't have time to process it." Katy added that, "I feel like if I would have more time to finish my problem – I had an extension where we would take the poll in our class and so it would allow the students to give their opinion and see." Abby felt pressed for time. She explained her teaching plan that, because she had teaching opportunities before where she went and taught in a "real life" classroom, she noticed the kids were:

> Super quick, they're interrupting me to talk," whereas, in SL, "I had to wait, and it was to
> a point where sometimes I would just not even get my answer to a simple question like

you all understand? And it'd just be silence. And I would be like, "Okay, moving on,"

because I was timed and needed all the time I could get.

In addition, Tori, and Tanya wished they had enough time to plan and teach their lessons. Tori

expressed how she would have prepared to teach. She stated:

I think that I would - I'd probably spend a lot more time on it and make it - I'd probably

clarify a lot more in my - what I was actually speaking, not actually what was on my

slides, but when I was actually speaking, and not be so nervous.

On the other hand, Tanya expressed her feeling of being in the classroom and getting timed out.

She elaborated:

I mean at first, you kind of feel like you're just talking to the class, but once the students

start asking you questions, you kind of feel like you're actually in the classroom, and then

I felt like I was there until they told me my time was up, and it was just like kind of like

you blink, and you realize that you're not – it was like when you read a book, you picture

yourself in the book with the characters. But then when the book ends, you're like, "Oh, I

wasn't ever really there." So, it was cool.

This is consistent with what Mutton et al. (2010) found that PSTs develop strengths in designing

learning tasks and using learning materials, but they are unable to engage students because of

their ineffective time planning, lack of experience, and limited exposure to students. These

problems challenge the abilities of PSTs to solve issues of culturally relevant teaching compared

to the traditional lesson teaching. This is also in line with what Gay (2013) asserts that teachers

express concerns that there is no time left for "teaching to and through cultural diversity" (p.59)

due to the time-consuming demands.

Found SL Teaching Practices Valuable but some Technical Limitations

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Several of the PSTs reported interacting well within the simulated virtual classroom in SL but, how the technology enhanced their teaching practices is unclear. The innovative nature of the virtual classroom, the SL visual and auditory tools they used in the simulation assisted PSTs in deepening their cultural knowledge and teaching experience. However, the findings appear to indicate that SL can provide a rich setting for new teachers to learn skills but it can also be challenging in their teaching practice teaching. For example, Linda said she enjoyed using Second Life while teaching and had a positive experience. She really liked the way she could look at the PowerPoint and the Smart [Podium] simultaneously. In other ways:

> I mean, I loved it because I played Second Life since I was 13 years old. So it was cool using it in a different way. And I liked being able to have the PowerPoint up in there and have the Smart Podium – is that what it's called? I never played with one of those before. It was fun.

Linda believed that the simulated classroom provided ample opportunities for her to have different practice teaching experiences. However, she had a few problems navigating between her lesson plans and the virtual technology. On the other hand, based on prior experiences Tori had her doubts about online classes. She said that the interactions between the students and the teacher were too distant. She said that she never learned well using that method. Notably, in designing these kinds of virtual teaching simulations, researchers must take PSTs prior experiences with technology into consideration, particularly if those experiences weren't favorable. Diana loved the Second Life experience and enjoyed using the Smart Board. She believed that the students' questions and feedback were realistic, and she had no complaints about not being able to touch the students or see their work up close. Thus, teaching is an active and demanding activity that is exemplified through PSTs in their practice teaching experiences.

Abby had both good and bad moments with SL. She mentioned the lag that made it difficult for her to answer questions quickly and within an allocated amount of time. Likewise, Sofia did not have good experiences with SL. She did not like using "the writing board, the question marks, the exclamation points, the PowerPoint slides and the online chats." She felt navigating between these tools to be overwhelming and too much to handle. She explained how visiting an actual classroom where she physically saw learners and had continuing face-to-face communication with them was more pleasant and easier than in SL which was more challenging. Sofia's assertion was that even though she realized the need to pay attention to individual learners and to affirm them in the classroom, where she was able to see faces and make up the difference of "who was who" made a difference. She emphasized that in her teaching experience in the simulated classroom in SL she did not see the avatars as students and could not identify most of them; therefore, communicating and collaborating with students in SL was quite different. Her comment was that "after my teaching-plan lesson I was told I didn't pay much attention to the kids, that I ignored two children or students and it's, like, well, I know in real life you're actually gonna see them." Although Sofia seemed to agree with the given feedback that reminded her to focus on the students, she again elaborated on the fact that engaging with students in the SL virtual classroom was challenging: "to see your kids, see that PowerPoint's working and see whatever you're writing is on. It's kinda hard to see, Oh, somebody has a question." Sofia also admitted that her teaching experience in SL during her lesson did not work well, specifically the integration of all aspects of teaching.

Rachal enjoyed preparing in the virtual classroom. She liked hearing the students' real voices and seeing the "bubbles" pop out with their questions. Like Abby, she did not like the time lag that occurred after students asked questions. She did not find it natural or realistic to

wait for a question while working on a timed schedule. Tanya had a good experience working in SL, but she disapproved of the lag and the "writing board." Similarly, Katy liked teaching in SL. She found the technology easy to use and interesting with its use of "pop-up bubbles and green symbols in place of speech." However, she expressed the difficulty of sitting behind a computer screen instead of interacting in front of the class.

These issues are consistent with Brown et al., (2011) believe that powerful technologies, such as virtual worlds and Second Life, can support the development of PSTs in providing a space for practice teaching. This is also consistent with Reiter and Davis' (2011) suggestion about the effect of bringing change to the traditional teacher preparation programs. In addition, what Gay (2009) suggests about preparing teachers to have advantage in today's classroom with increasingly diverse student populations informs this work.

Student Engagement

As it relates to the preservice teachers' making connections with students from their lesson plans, each of the participants' expectations fed into their influence. For example, Linda expressed doubt, Tori said it was easy to communicate, and Diana said that she did not prepare for students' questions. As to what they wanted the students to engage in related to the content knowledge focus of the lessons, some of the preservice teachers thought they'd engage students in their algebra problems but ignored other problems. Tanya stated, "Yes, except for the part where I didn't really know who was talking, but I still tried my best to be like, Okay, what did you say, Yes? Who has their hand raised?" Linda explained it this way, "No, actually it didn't. I realized that there were a lot of hands." Rachal also explained:

> I felt like – I don't know. I found it really interesting, the graph first of all and I was like
> "Well what can I have them find on the graph? What information can you use from a

graph?" so then I went back and of course I knew the maximum and minimum 'case that's kind of given. I was like "Well what information, what other information could they find?" and so that's why I kind of looked up what can you find if you're given a graph and kind of just picked the average and the percent increase. (Rachal).

This aligns with what Marshall (2002), states that teaching involves teachers interacting with all students. However, interactive teaching is difficult for PSTs because it requires more planning, time management, and reliance on students to take an active role in their learning. When PSTs are caught in the demands of the requirements, they quickly lose sight of engaging ideas. For example, according to Tori, throughout her lesson, she was trying to meet the requirement for the course. She explained:

I didn't take it too seriously because I knew they weren't really middle-grade students, but at the same time, you're like, well, I'm still getting graded for this, so I still want to - I can play my part and they're playing theirs.

Some preservice teachers' interview transcripts also showed failure to engage students in critical thinking, feedback, praise, and task interactions. Student engagement was mentioned in over half of the preservice teachers' reflections, but not enough of them engaged in the context of constructing students' knowledge.

The findings show that most of the preservice teachers perceived their teaching plans with mixed feelings and a few with the frustrations of failing to engage students. Abby reflected that she and the students often had questions:

I went off the TEKs objectives, so I felt like they should have known it – but they didn't. So, it did help to write out everything so they can see, and I also had to monitor their comprehension. I had to ask like, "Do you all understand?" Because there were times –

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one kid was like, "She's going too fast." So, I had to go back and kind of explain. And a lot of them I didn't even know the answer to and it's kind of like, you're timed, and you want to be right, but you don't have time to process it, so yeah. It's things I didn't even consider.

Implications for Practice

The implications for practice for this research rests on the need to explore the complex issues of teaching culturally relevant lessons. We need to better understand how preservice teachers' perceptions and their experiences influence how they engage with students. This study suggests that teacher educators seek meaningful teaching practices that engage PSTs to examine and critique their own perceptions as well as possible biases. In short, preservice teachers should engage in critical self-reflections of themselves and their students to understand their position and the work needed for change.

This study has provided important insights into preservice teacher candidates' perceptions of their experiences with mathematics, understanding diverse students, and CRT which has implications for teacher preparation coursework and the design of practice teaching experiences. The findings suggest that coursework and opportunities for practice-based teaching experiences focused on culturally relevant teaching are critically needed in teacher preparation, and more specifically, in the preparation of mathematics teachers (Fox & Larke, 2014). These opportunities can provide powerful ways to better prepare preservice teachers to design and teach culturally relevant mathematics lessons. However, the current study revealed that several conditions and considerations are paramount in enacting experiences to effectively accomplish this. Several insights can be drawn from this study. In the context of the KATE Project, preservice teachers should engage in authentic preliminary experiences to learn more about

students' cultures and interests, prior to designing lessons. They should be given extended time and multiple opportunities to engage in practice teaching experiences, including increased time to reflect on their teaching. Technical issues must be solved so that they do not provide distractions from teaching simulation experiences. Finally, models of effective culturally relevant lessons must include exemplary examples, instead of what Nelson and Guerra (2013) refer to as visible elements of culture (food, ceremonies, language, music etc.).

This study showed that PSTs' perceptions are not static or unchangeable. To Ladson-Billings, the study of one's self and others' viewpoints in the context of lived-experiences might provide young teachers with self-awareness. This study reinforces that some PSTs' understood diverse students and their background as valuable resources for their teaching. Thus, carefully designed problem-solving coursework and teaching practice similar to the experiences analyzed in this study are necessary for teacher candidates to strengthen their awareness and knowledge of cultural diversity.

Culturally relevant issues related to qualitative research have great value. They offer a foundation to help PSTs understand how culture influences mathematics teaching and learning. Although the findings of the current study are limited to the eight cases and are not "generalizable" or "transferable" (Creswell, 2012), the identification of PSTs collective experiences adds to the existing body of literature to provide possible directions for future research (particularly for KATE project researchers). The lessons learned, and particularly the things that didn't work as effectively, can inform improvements to similar teaching simulation design by KATE project researchers. Additionally, some of the findings may prove useful to teacher educators who are interested in preparing culturally responsive mathematics teachers.

The implications of this study lie in the current model of teacher preparation that leaves preservice teachers' identity, attitudes and behavior unquestioned or unchallenged. This study's findings suggest that PST cultural knowledge and skills should be initiated from the very beginning of teacher preparation programs and through practice-based experiences. When new teachers enter the classroom, they should be aware of the ways with which to engage with culturally diverse students. Cultural relevant knowledge should move beyond coursework to explore self-examination.

Another implication lies in the realization that lived experiences shape who we are and how we interact with others. In this study, PSTs interactions with students while practicing teaching was mostly a reflection of PSTs' past beliefs and experiences; therefore, more work is needed. If PSTs are to change their perceptions, they must first acknowledge their own deficit beliefs and begin the work on undoing them. They must actively critique themselves and their actions. They must see diverse students' experiences as valuable knowledge.

In this study, the integrated teaching practice was meant to provide a foundation for PSTs teaching experiences; it was not meant to be the sole introduction to their culturally relevant education. Although it was an important element toward facilitating teacher candidates' learning and algebra problem-solving, it also assisted PSTs in reflecting upon their own self-identity and how this affects them as future teachers. Therefore, presenting cultural diversity as an asset, and not as a negative to be managed in the classroom, helps preservice teachers to embrace the framework of culturally relevant pedagogy. More research is needed to better understand the complex and challenging practices of teaching diverse classrooms today.

Recommendations

Recommendations for further study include:

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1) Conduct a cross-case analysis of another sample of preservice teachers that participated in the KATE Project to see if similar themes and findings emerge from a follow-up study.

2) Conduct a mixed-methods study with the same eight preservice teachers, and explore what can be learned and triangulated from the qualitative cases and quantitative measures that the participants completed (e.g., the virtual classroom observation instrument data).

3) Future studies might also examine preservice teachers' improvements over time in designing and teaching culturally relevant lessons. For example, researchers can explore this as they advance to later field experiences.

4) Convene and collaborate with scholars with expertise in mathematics problem solving and multicultural education to develop a set of exemplary culturally relevant mathematics lessons, and explore whether they provide more effective models for preservice teachers enrolled in the mathematics problem solving course in the future.

Summary

In conclusion, the innovative nature of the virtual classroom environment, the interactive visual and auditory tools used in the simulation assisted PSTs in deepening their cultural knowledge and teaching experience with students in meaningful ways. These findings appear to indicate that SL can provide a rich setting for new teachers to learn specific algebra teaching skills that also challenges their diversity of knowledge. This SVC environment provides preservice teachers with risk free opportunities to carry out teaching within the context of a university methods course and teaching practices under the supervision of their instructor.

The KATE Project did the work of facilitating teacher candidates to learn through their coursework and practice-based teaching experiences. The alignment between the problem-solving course and the simulated virtual classroom in SL addresses the contradiction in some

teacher preparation programs and culturally relevant teaching. Especially in supporting teacher candidates as they engaged in practice-based teaching experiences, they are provided access to algebra practice and cultural knowledge building. Because the university instructors had knowledge of both contexts, they are better able to connect the learning trajectories of the PST to move back and forth between the problem-solving coursework and the SVC (middle-grade classroom) in SL. This practice-based learning aligns the practices that preservice teachers are learning in the MASC problem solving coursework and the enactment of these practices in the SVC. The preservice teachers have opportunities to learn the problem-solving coursework and practice through teaching in the middle-grade SVC classroom. They are able to plan and teach in a simulated classroom, and then reflect on their teaching, before entering an actual classroom themselves in later traditional field experiences.

This study adds to the literature on preservice teaching and helps to make the case for the integration of CRP in teacher preparation coursework. During the teaching practices in the simulated virtual classroom, preservice teachers taught 20-minute lessons to diverse avatar students in the presence of experienced instructors who understood how to implement culturally relevant pedagogy. Even though the practice was short-term, it proved somewhat effective as preservice teachers actively engaged in self-reflection and critique of their own teaching. Throughout their practice teaching experiences and interactions with students, some preservice teachers noticed student misconceptions as they tried to incorporate culturally relevant teaching practices. In this study, the SVC environment proved to be an effective and viable means for preparing teachers. Furthermore, the structure of the SVC design enhanced the delivery of lessons as well as interactive instructional approaches. Evidence of growth in the participants is noticeable in Second Life and expands the opportunity for the design of meaningful lessons in

teacher preparation. More research should be done on role-play and simulation so that the voices of preservice teachers can continue to be shared.

Finally, this study's findings provide an opportunity to enhance teacher preparation by strengthening the focus on mathematics preservice teachers. The study recommends that teacher preparation programs use culturally relevant pedagogy as the underlying framework for mathematics education coursework. This case study provided no information about how the participants might teach mathematics in the future with culturally diverse learners in a real classroom. Consistent with past research findings, it is expected that these preservice teachers' beliefs will undergo developmental changes once they begin their teaching careers (Kennedy, 1999; Guillaume & Kirtman, 2010). A research project could follow this study. Guillaume and Kirtman (2010) had stated that teachers are products of the educational system they pass through as students and re-enter as teachers they tend to teach the way they were taught. Teacher preparation programs should continue to work to alter or reshape PSTs' deficit perceptions of teaching and interaction with culturally diverse students.

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PROTOCOL FOR PRE-SERVICE TEACHER POST-SECOND LIFE TEACHING

INTERVIEWS

Spring 2013

April 15, 2013

MASC 351

1.   What worked and didn't in your teaching plan?

2.   What worked and didn't work in regards to 2nd life?

3.   What was your experience creating your problem for Second Life?

4.   Did the experience of giving your lesson in SL allow you to engage with the middle grade student avatars in a meaningful way, if so how, please explain?

5.   Did you have a sense of being present or being there in the virtual learning spaces, when you participated in SL activities or gave your lesson, if so, please explain?

6.   Were you able to communicate and engage with others in the SL classroom with ease, please explain?

7.   How did you prepare your lesson to engage with the students? Did you use culturally relevant teaching or critical pedagogy?

8.   What mathematical concept did you choose and why?

9.   Now that you've gone through this once how would change the planning of your lesson and /or the instruction?

10.   How did you feel about the questions raised and the feedback from the avatars, was it realistic to a school environment? Why or why not?

11.   Was there something that frustrated you during your teaching experience?

12.   Was there something that led to an insight?

13.   What advice would you give to other students about to give their lesson in Second Life?