ABSTRACT

DOWNING, GREGORY ALONZO. Leveraging Culturally Relevant Pedagogy in a College Algebra Course: A Mixed Methods Study. (Under the direction of Dr. Karen Hollebrands).

College algebra is a gateway to graduation for many non-STEM college majors (Van Dyken, 2016). Each year, only 50% of students earn grades of A, B, or C in these courses (Ganter & Barker, 2004). This means that half the students enrolled in this entry mathematics course receive grades of D, F, or withdraw from the course. This is extremely problematic when we couple this with the fact that most college majors require students receive a C or better in this course to make adequate progress toward their degree. The effect of teaching with culture has been shown to have positive effects on student achievements. Studies showed that students were able to remain focused on tasks during class (Ensign, 2003), students scored higher on formative and summative assessments (Enyedy & Mukhopadhyay, 2007), and students took a higher interest in mathematics when they were able to create problems related to their own lives (Hubert, 2014). One instructional approach that connects learning to culture is culturally relevant pedagogy. Culturally relevant pedagogy is founded upon three principles: academic rigor, cultural competence, and sociopolitical consciousness (Ladson-Billings, 1995a).

The purpose of this embedded (QUAN(qual)) quasi-experimental mixed-methods research study was to investigate the effects of a sequence of lessons grounded in the principles of culturally relevant pedagogy on students enrolled in a college algebra course at a historically Black university. In particular, the study examined students’ achievement, their views about mathematics and its interaction with culture, and abilities to apply mathematics to address sociopolitical problems. Two classes of students, an experimental group and a control group, engaged in mathematics lessons that were grounded in good, rigorous mathematical teaching practices; but the experimental course received lessons that also incorporated principles of
culturally relevant pedagogy. Results indicated that students in the experimental course showed significant quantitative gains on the various measures related to academic achievement, self-efficacy, and cultural competence in mathematics. Further, findings also suggest the need for instruction to have more emphasis on cultural components to build students’ sociopolitical consciousness, because this is integral in helping students be able to think critically and use mathematics in their everyday lives. Students in this experimental course were able to discuss difficult issues, such as the pervasiveness of racism in America (DeCuir & Dixson, 2004) and the importance of cultural identity for African American students (D. B. Martin, 2009). Suggestions for instructors incorporating culturally relevant pedagogy and recommendations for future research are provided.
Leveraging Culturally Relevant Pedagogy in a College Algebra Course: A Mixed Methods Study

by

Gregory Alonzo Downing

A dissertation submitted to the Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Learning and Teaching in STEM

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APPROVED BY:

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Dr. Karen Keene                   Dr. Jessica DeCuir-Gunby
DEDICATION

This dissertation is dedicated to Christopher (CJ) Cohen, Matthew Gibson, and James Betts. I hope this serves as a small return on investment of all the encouragement and support that each of you have shown me while I was your teacher and now, friend.

CJ: You are the cooler, younger version of myself. Smart, ambitious, and destined to achieve all you wish for and more. You walked in my classroom as my “son” and you left as my friend. Continue to be smarter, cooler, and more driven that I could ever be.

Matthew: You are constantly teaching me to be myself and love myself. You make it look so easy... You came in my class being a smart-ass... and you still are. :) I know you will become a powerful voice for your generation on the things that actually matter. Speak out and no more shenanigans!

James: You are one of the most brilliant students I have ever had the opportunity to teach. You are a loving and caring gentle spirit, and I have been able to learn so much from you. I know you will continue to show the world your virtues of humility and kindness. We need more of it these days.

All of you have changed my life for the better in very different ways, and I believe I am a better educator, mentor, person, and friend for have known you. Thank you and I love you all.

~Downing
BIOGRAPHY

Gregory Alonzo Downing was born in Edenton, North Carolina on October 5, 1990 to George Downing Sr. and Karen Downing. Gregory is the youngest brother to Domonique, George Jr., and LaQuita.

During his senior year at John A. Holmes High School in 2008, Gregory was awarded the prestigious Gates Millennium Scholarship, an extremely generous scholarship from the Bill and Melinda Gates Foundation, which paid for college at all levels of higher education. Gregory took this scholarship and went to The University of North Carolina at Chapel Hill where in 2012, he earned a Bachelor’s of Arts in Mathematics with a second major in Sociology and a minor in Music.

Upon graduation, Gregory went directly into enemy territory at Duke University to earn a Master’s of Arts in Teaching with a concentration in Secondary Mathematics in order to become a high school mathematics teacher. During his first of two teaching internships in the Durham Public Schools system, under the tutelage of recently retired Ms. Coach Pam Adams, Gregory worked with the Young Men of Progress (YMOP), a group of first year African-American males labeled “at-risk” of graduating, at Northern High School in Durham, North Carolina. This experience convinced him that teaching was his calling.

After graduating in 2013 from Duke University, Gregory immediately began teaching at Northern High School (#H33foreveer). At this time, he also began working on a second graduate degree at North Carolina Central University also located in Durham, North Carolina, working on a Master’s of Science in Mathematics. During his third year of teaching high school, Gregory earned his M.S. in Mathematics, graduating summa cum laude in 2015. Being at the same high school for four years at this point (one year student teaching and three years teaching), Gregory
saw his first full cycle of students graduate in 2016. It was at this point, he realized that he wanted to address some inequities he saw and impact more students on a larger scale; thus, he decided to leave secondary teaching to pursue a Doctor of Philosophy in Learning and Teaching in STEM – Mathematics Education at North Carolina State University in Raleigh, North Carolina.

During his first year at NC State, under the much-appreciated guidance of Dr. Cyndi Edgington, Gregory taught his first university-level course, EMS 204 – Introduction to Teaching Mathematics and he knew he had made the right decision. Gregory carried multiple hats as a graduate student by not only working as a graduate teaching assistant for the STEM Education department teaching both undergraduate and graduate courses, but also as a University Supervisor to prospective middle and high school mathematics teachers, and as a graduate research assistant to Dr. Karen Keene. Gregory successfully continued to be an effective university student, teacher, and scholar at NC State so, he picked up courses at other Triangle-located universities teaching mathematics and statistics courses at North Carolina Central University and Meredith College (in Raleigh, North Carolina).

Upon completion of his Ph.D. in Learning and Teaching in STEM, Gregory will take his talents and research interests in culturally relevant pedagogy in college mathematics back to his alma mater, North Carolina Central University in Durham, North Carolina where he will be a teacher and researcher within the School of Education as an Assistant Professor in the Curriculum and Instruction department focusing on Mathematics and Science Education starting in the Fall 2019 semester.
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There are way too many people that have helped me get to where I am right now. I apologize that I do not have another 200+ pages to mention everyone, but I will do my best.

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First, and foremost, if it were not for Dr. Karen Hollebrands, I would probably still be trying to figure out what I wanted to do a dissertation study on. You have been and done so much for me these past few years and I would not be able to be the researcher and critical thinker without you. The time and energy you have devoted to me, alone, along with the other thousand things you are involved with is mind-boggling. After jumping around to five different advisors, I found you and with that came solace and comfort in your office. You challenged me in ways I did not believe I could achieve, but with your guidance and “encouragement” (and by “encouragement” I mean ‘ambitious deadlines’), I would be still floundering in sea of endless literature. You are truly the G.O.A.T. Thank you so much for everything. I hope to at least be half the mentor to my proteges as you have been for me.

I would also like to thank the rest of committee members Dr. Karen Keene, Dr. Lee V. Stiff, and Dr. Jessica DeCuir-Gunby for all the help and talks we have had concerning my dissertation and other course work throughout the duration of my time here at NC State. Dr. Keene, you taught me the basics of how to conduct research. I thank you for this early and great start to my career. Dr. Stiff, I met you and Dr. Keene at the College of Education’s open house five years ago. From the moment I met both of you, I knew NC State would be home and you two would be key factors to my success. Thank you. Dr. D-G, the first course (of three) I took with you, Critical Race Theory in Education launched me on the culturally relevant pedagogy train I currently find myself on. All your classes have been life changing and amazing. I really hope we have opportunities to work together in the future.
To My NC State Friends:

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To Dr. Christina Azmy, you have truly made writing this dissertation somewhat bearable. I could not imagine going through this pure hell alone. You started out giving me the best advice anyone has given me when it came to my comprehensive exams: “write while you read.” You followed up this magical nugget by introducing me to HQ Trivia; the game that continues to make us rich $0.02 to $0.10 once every 30 nights (while Taylor is racking up $0.10 almost every other night). You even started our chapter of the HQ-ties with Taylor and Heather! You understand all my The Office references!!! You convinced me to do Camp Completion when you said you were doing it. Being in the quiet LOUD room was one of the most productive weeks of writing during this entire process. Thank you so much for all these small gifts of joy you have bestowed upon me this past year. Again, I could not have imagined going through this process without you… I literally believe it would not have been possible!!!

To my fellow NC State Math Ed family who started this program with me and are still in the trenches and have yet to truly realize the dire situation you will soon find yourselves in
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To Dr. Domonique Downing, Dr. Kanisha Coleman Brevard, and Dr. Felix Nwogbo who have already traversed this journey and have beautiful melanin spread across their faces as I do, I acknowledge you. Without you, I never would have thought this was possible for me. Each of the many times I felt like giving up and walking away, I looked to you for motivation and I found it in just knowing you survived. I hope I can inspire another little Black boy, like myself, to finish this arduous race.

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CHAPTER 1: INTRODUCTION

While algebra is a gateway course for high school graduation (Moses, 1989), college algebra is a gateway to graduation for many non-STEM college majors (Van Dyken, 2016). Each year, only 50% of students are successful enough to earn a grade of A, B, or C in their college algebra courses (Ganter & Barker, 2004). This means that half the students who are enrolled in what is, most likely, the most elementary version of a college mathematics class are receiving grades of D, F, or are withdrawing from the course to avoid a failing grade. This is extremely problematic when we couple this with the fact that most college majors require students to receive a C or better in this course to make adequate progress toward their degree.

Minority students continue to face numerous barriers to achieving in mathematics courses (Barton, 2003; Saxe & Braddy, 2015). Due to the negative side effects of “gap gazing” (Bol & Berry III, 2017) minority students are often regulated and oppressed under the guise of teachers “doing what is best for their students” (Higgins & Moule, 2009). This gap gazing problem is so exorbitant, researcher Rochelle Gutiérrez called it “a fetish in mathematics education” (Gutiérrez, 2008, p. 357). Negative connotations follow this mindset, for it may support teachers in viewing minority students through a deficit perspective lens. This lens leads to teachers holding beliefs of their students that they are not able or capable of critical thinking and therefore must be explicitly told the information they need to remember. This can lead to teachers solely (or dominantly) relying on traditional approaches to teaching (i.e. direct lecturing). Freeman and colleagues showed in a study how failure rates for students who are taught primarily using traditional lecturing are 55% higher than that observed for classrooms that use a more active approach to learning (Freeman et al., 2014).
Deficit perspectives, traditional instruction, and low expectations are factors that help influence whether students take more advanced coursework in high school. When students are not advised to take more advanced courses, they are inadequately prepared for college. This often results in students being placed in college algebra where failure rates are extremely high (Holloway, 2004). There is a clear need to help struggling students in developmental mathematics courses and to improve the way these mathematics courses are taught (e.g. Carnevale, Smith, & Melton, 2011; Fairweather, 2008; Griffith, 2010; Hurtado, Eagan, & Chang, 2010; Pascarella & Terenzini, 2005; PCAST, 2010; Rasmussen & Ellis, 2013). Researchers have explored various ways to help combat negative learning experiences for students of color by teaching for social justice and by using culturally relevant pedagogy (Gutstein, 2003; Ladson-Billings, 1995b, 1995a).

Social justice pedagogy is an equity-oriented practice that is conceptualized by what is and what is not fair and just with regards to the relationships between the individual and society (Baily & Katradis, 2016). This is measured by the explicit and implicit ideas of wealth distribution, opportunity, and social privileges based on one’s social status in society. Social justice is often referred to as something researchers and educators move towards, never quite reaching it for “[i]t is in seeking to understand the ways in which we simultaneously accept/unaccept the other that we move closer to becoming agents of social justice” (Aguilar, Nelson, & Niño, 2016, p. 252). Practitioners and researchers interested in social justice have found ways to address inequitable learning opportunities. Some have done so using culturally relevant pedagogy, which integrates cultural identity of the students involved and academic rigor of the content being taught.
Culturally relevant pedagogy has teaching mathematics for social justice at its heart. It has roots grounded in critical theory (critical pedagogy). It looks beyond such notions of functional mathematical literacy. With regards to mathematics, it concerns itself with gaining mathematical knowledge and skills that are necessary for participating in society as it is now, in turn, pushing towards critical mathematical literacy. This emphasizes the development of knowledge, practices, and discourses for transformative purposes (Tan, Barton, Turner, & Gutiérrez, 2012). These transformative purposes come from Freire (2000) who reminds us that education should provide opportunities to understand, challenge, and re-create preconceived understandings of the self and of the world. With culturally relevant pedagogy (Ladson-Billings, 1995a, 1995b, 2014), the goals are clear: to afford students who have been historically marginalized the “opportunity to achieve” (Robinson, Bradley, & Stanley, 1990). The effect of teaching with students’ culture has shown to have a substantial increase in self-confidence and self-efficacy; effectively replacing feelings of failure and alienation that is all too common with the subject of mathematics and students of color (Tate, 1995).

Culturally relevant pedagogy is founded upon three principles: academic achievement, cultural competence, and sociopolitical consciousness (Ladson-Billings, 1995b). Academic achievement is the idea that the content students are learning is grounded in rigor and not watered-down versions of required curriculum. It also includes equipping students with the knowledge that will help them succeed not only in the short-term, but also the long-term. Cultural competence is the idea of helping students to appreciate and utilize the cultures that they bring with them to the classroom, but also to gain access to the culture of the dominant groups to help better position them to succeed in society. Sociopolitical consciousness is equipping
students with the knowledge to view social things that are also political that are happening in their local communities, nationally, and also globally through a critical lens.

**Research Questions**

The purpose of this research study is to investigate the following hypothesis: Student outcomes, including self-efficacy, will be improved by participation in a college algebra course at a historically Black college/university where the instructor uses culturally relevant pedagogy in the course. The research questions were designed to align with Ladson-Billings’ (1995a, 1995b, 2014) theory of culturally relevant pedagogy. Research questions one and two align with academic achievement, research question three aligns with cultural competence, and research question four aligns with sociopolitical consciousness.

The following research question will be addressed:

1. What effect does culturally relevant pedagogy have on student achievement in a college algebra course offered at a historically Black university?
2. How are student’s views about mathematics affected in a course centered around culturally relevant pedagogy?
3. How do students enrolled in a college algebra course at a historically Black university define and describe their culture and their experiences with lessons designed to be culturally relevant?
4. How are college algebra students able to critique discourses of power using mathematics as a tool?

**Overview of Methodological Approach**

This research study will be guided by Creswell and Plano Clark’s (2018) definition of mixed methods research in which the researcher:
collects and analyzes both qualitative and quantitative data rigorously in response to research questions and hypotheses,

integrates (or mixes or combines) the two forms of data and their results,

organizes these procedures into specific research designs that provide the logic and procedures for conducting the study, and

frames these procedures within theory and philosophy” (p. 5)

This study utilizes an embedded (QUAN(qual)) quasi-experimental mixed methodological design, which includes both quantitative and qualitative data. The quantitative data will be used to test whether including culturally relevant pedagogy in a college algebra course at a large historically Black college/university will positively influence student achievement and self-efficacy. The qualitative data will contribute additional information to examine students’ self-efficacy and explore the ways in which students are able to critique discourses of power using mathematics as a tool. The two forms of data will be combined to make research claims about a population of students who have largely been excluded from prior research. The goal of this study is to help future students not only succeed in mathematics, but also allow themselves to be seen as capable students with mathematical ability. This can contribute to reducing achievement gaps experienced by minority students.
CHAPTER 2: LITERATURE REVIEW

With the growth in diverse students in America and the ever-widening achievement gaps (Próspero & Vohra-Gupta, 2007; Roksa et al., 2017), we must research and invest in pedagogical approaches that are specifically geared towards students of color who stand to benefit most. Underrepresented minority groups, including African Americans, Hispanics and Latinos(as/x), and others are groups that make up a sizable proportion of the population in the United States, around 30% (US Census Bureau, 2017). There has been some research that has been conducted (and is currently being conducted) on how best to improve aspects of the education system to impact a diverse group of students and their teachers (Ladson-Billings, 1995a, 1995b; D. B. Martin, Anderson, & Shah, 2017). However, much of this research has been conducted in grades K-12 levels with less focus on higher-grade levels. Even less research has been conducted at the college level.

Powell and Frankenstein (1997), editors of the anthology: *Ethnomathematics: Challenging Eurocentrism in Mathematics Education*, state that "In the Eurocentric account, Europe (and “Europeanized” areas like the U.S.A.) has always been and currently is the superior Center from which knowledge, creativity, technology, culture, and so forth flow forth to the inferior Periphery, the so-called underdeveloped countries" (p. 1). This notion of what is right and who created it is problematic on multiple levels. Thus, researchers are working to fight to end these and other similar notions that mathematics is naturally, and by definition, “neutral” with regards to culture and the teaching of it (Nasir, Hand, & Taylor, 2008). Mathematics is not culturally neutral. Thus, it is worthwhile investigating how an approach to teaching mathematics that embraces the culture of students affects students’ engagement with and performance in
mathematics. In the next section, I discuss the theoretical lens for the proposed research study, culturally relevant pedagogy.

**Culturally Relevant Pedagogy**

Gloria Ladson-Billings created a model of teaching, culturally relevant pedagogy, that places cultural respect and appreciation at the center (Ladson-Billings, 1995a, 1995b, 2009). Ladson-Billings (1995b) states that culturally relevant pedagogy is “a theoretical model that not only addresses student achievement but also helps students to accept and affirm their cultural identity while developing critical perspectives that challenge inequities that schools (and other institutions) perpetuate” (p. 469). Culturally relevant pedagogy is also empowering and allows students to use cultural resources they bring to school from home in order to connect with what they are learning to society, politics, and their emotions (Ladson-Billings, 1995a). Culturally relevant pedagogy is built upon three main tenets: (1) academic achievement, (2) cultural competence, and (3) sociopolitical consciousness.

**Tenets of Culturally Relevant Pedagogy**

**Academic achievement.** The first tenet of culturally relevant pedagogy is academic achievement. While some interpret this to mean standardized test scores, students’ academic achievement, Ladson-Billings warns that this phrase should be described as “student learning” – what it is the that the students actually know and are able to do as a result of pedagogical interactions with skilled teachers” (Ladson-Billings, 2006b, p. 34). This student learning is the primary focus of how teachers should be thinking deeply about. It is focused on what is being taught to students and why these topics should be brought before them. Teachers must attend to every lesson to make sure the tools they are using are actually being useful to attend to their goals for their students. Often students are subjugated to ready-made curricula; however, this is
typically, is not good enough for it often does not consider the long-term (and other tenets of culturally relevant pedagogy). Academic achievement must be focused constantly on students and their long-term academic success and not just short-term or daily mundane goals that teachers tend to primarily focus on (Ladson-Billings, 2006b).

Academic achievement is not separate from a specific content area’s goals of academic rigor. It does not completely argue for what content should be included or excluded from curricula, but it does argue how that content should be taught in order to better meet the needs of students. In a mathematics classroom, this would refer to students not solely learning only procedural concepts or formula for the sake of performing calculations on a test or exam that is approaching, rather, conceptual understanding. Instruction for students should be crafted with horizontal thinking geared towards larger concepts that will build upon concepts that are being learned, that will be utilized in subsequent courses. In this particular study, this was done by having them working in groups to aid them in cooperative learning and critical thinking. Students practiced these skills and those of data exploration and analysis that would not only prepare them if they were to take additional mathematics classes, but also in other content areas and life, in general, where these skills would be needed.

**Cultural competence.** The term cultural competence means many things in other disciplines. Ladson-Billings (2006b) tells us that in professional fields, this term normally means how people in the dominant groups become more skilled in noticing cultural messages that their clients may portray. When teachers take this view of the term (replacing ‘clients’ with ‘students’), this causes them to become extremely hesitant to address issues or statements in the classroom, often causing them to seek the advice of a more seasoned or veteran teacher which in turn causes reinforcement of serotypes rather than nixing them. Ladson-Billings uses this term to
mean aiding “students to recognize and honor their own cultural beliefs and practices while acquiring access to the wider culture, where they are likely to have a chance of improving their socioeconomic status and making informed decisions about the lives they wish to lead” (Ladson-Billings, 2006b, p. 36).

In mathematics classrooms, this would include varying contexts and situations used that are used in word problems or being used to teach topics. Teachers can use contexts that are familiar to students, after getting to know who their students are, but also contexts that helps their students acquire knowledge about the structure real world and life beyond school, such as rent, loans, credit, and other topics. Specifically, in this study, topics to address building students’ cultural competence began with looking at who the students are (age, race, majors, interests, etc.), then coming up with topics that would interest them. Topics included issues that are relevant to 18 and 19-year-old first-year college students, such as student loans, banking, and the connections between dating and sexually transmitted disease contraction. This also extended to students’ interests in activism and things salient with being African-American with topics like incarceration and population modeling.

**Sociopolitical consciousness.** The third tenet of culturally relevant pedagogy is sociopolitical consciousness. This is concerned with students becoming more conscious of sociopolitical issues not only on a national or a global level, but perhaps even more so on a local level. These instructors who are attune to this tenet are, to use a popular word, “woke” to the issues that are most salient to the students (even if the students are unaware of them). Ladson-Billings (2006b) charges potential cultural relevant teachers to first, educate themselves on these issues and second, they must “incorporate [these] issues into their ongoing teaching” (Ladson-Billings, 2006b, p. 37). The focus, again, should always be on the students and what is in their
best interest and not teachers who wish to pushing their own agenda. This tenet refers to finding ways for “students to recognize, understand, and critique current and social inequalities” (Ladson-Billings, 1995b, p. 476).

In a mathematics classroom, this could take the form of multiple concepts. One could be looking at the wealth distributions in the world (sociopolitical context) and how ratios and proportions (mathematical content) can be used to expose this social justice topic (Gutstein & Peterson, 2005). In this study, this will happen through lessons focused on race and population modeling and incarceration.

**Culturally Relevant Pedagogy, 2.0**

Ladson-Billings “remixed” her theory of practice to align more with Paris’ work with culturally sustaining pedagogy (Ladson-Billings, 2014). She explains that pedagogy has to and should be constantly evolving to meet the needs of students. Ladson-Billing (2014) states that “[a]ny scholar who believes that she has arrived and the work is finished does not understand the nature and meaning of scholarship” (Ladson-Billings, 2014, p. 82). However, reducing culturally relevant pedagogy to merely one or two days on people of color or posting images of “diverse” people of color goes against the core foundational values of culturally relevant pedagogy. The term should not be used lightly or as a buzz phrase of the day. Therefore, when referring to “culturally relevant pedagogy” henceforth, I mean culturally relevant pedagogy, 2.0. In the next section, I mention how the negative effects gap gazing relates to culturally relevant pedagogy and how not addressing the root of the gaps will lead to ineffective teaching practices.

**Culturally Relevant Pedagogy and Gap Gazing**

Culturally relevant pedagogy is a theory that is combating notions that particular students lack the ability to succeed at certain levels. When given curriculum that caters to the needs of
students, they are able to succeed in a multitude of ways (Ladson-Billings, 1995b, 2006a). This is an important theory that is needed in mathematics education in order to address the achievement gap. It can also counter pitfalls that are apparent in the teaching and learning of culturally diverse students, which is further contributing to that gap. Paying too much attention to these “gaps” can also be problematic for minority students (Bol & Berry III, 2017; Gutiérrez, 2008). Minority students are often limited in the type and styles of instruction they receive due to this fixation on “gap gazing” that is self-justified by educators as “doing what is best for their students” (Higgins & Moule, 2009). In reality, these negative connotations that minority student cannot do or perform certain actions is counterproductive and oppressive. This deficit perspective approach to learning and education lead educators to believe that these students lack the ability to think critically; therefore, they must be explicitly told facts they need to know and not pushing them to think more deeply (Adiredja & Zandieh, 2017). In mathematics, the use of tasks to support this type of teaching can be classified as memorization or procedures without connections (National Council of Teachers of Mathematics, 2014; Smith & Stein, 1998).

These deficit approaches also lead to lower expectations that further contributes to students not taking more advanced coursework in high school, which results in inadequate preparation for college. These deficits add up to staggering deficits in the quality of education certain groups of students are receiving. Struggling students of color are, and have been for quite some time, the inheritors of this debt, resulting in the unwavering achievement gaps that are still seen to this day (Barton, 2003; C. Johnson & Kritsonis, 2006). There is a clear need to help struggling students in mathematics courses to improve the way it is taught to help students understand material (e.g. Griffith, 2010; Hurtado, Eagan, & Chang, 2010; PCAST, 2010). In the
next section, I acknowledge various similar (and different) theories that other authors (Geneva Gay and Django Paris) have created to also address the education of minority students.

**Distinguishing Culturally Relevant Pedagogy from Culturally Responsive Teaching and Culturally Sustaining Pedagogy**

There are other theories that have been developed since the inception of culturally relevant pedagogy that connect to the culture of students. Two that have gained the most traction in educational research include culturally responsive teaching (Gay, 2002, 2010, 2018) and culturally sustaining pedagogy (Paris, 2012). It is important to mention these bodies of literature because they have helped to heavily influence the power of culturally relevant pedagogy and its subsequent tuning of the theory itself. All have heavy presence in the literature and stem from the same needs of diverse student learners.

**Culturally responsive teaching.** The term culturally responsive teaching is a phrase that describes the pedagogy that “[uses] the cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits [to] teach them more effectively” (Gay, 2002, p. 106). This form of pedagogy should be seen as “validating and affirming” (Gay, 2018) because:

- it acknowledges the legitimacy of the cultural heritages of different ethnic groups, both as legacies that affect students’ dispositions, attitudes, and approaches to learning and as worthy content to be taught in the formal curriculum;
- it builds bridges of meaningfulness between home and school experiences as well as between academic abstractions and lived sociocultural realities;
- It uses a wide variety of instructional strategies that are connected to different learning styles;
- It teaches students to know and praise their own and one another’s cultural heritages;
• It incorporates multicultural information, resources, and materials in all the subjects and skills routinely taught in schools. (p. 37)

Culturally responsive teaching has been updated recently (Gay, 2018) and is understood to be built upon six dimensions:

1. Culturally responsive teaching is comprehensive and inclusive. Teachers attend to “the whole child” (p. 38) and not just the academic side. Students are held accountable for their own and each other’s learning. Teachers set high expectations for all their students in order to promote empowerment socially, as well as academically.

2. Culturally responsive teaching is multidimensional. This “encompasses curriculum content, learning context, classroom climate, student–teacher relationships, instructional techniques, classroom management, and performance assessments” (Gay, 2018, p. 39). Teachers must be able to engage with different cultural knowledge, experiences, and contributions.

3. Culturally responsive teaching is empowering. Teachers have to make students believe that they can succeed in a learning environment. They also have to make a personal commitment to make that happen.

4. Culturally responsive teaching is transformative. By using students’ existing strengths, teachers drive instruction to academic success by allowing students to utilize these skills.

5. Culturally responsive teaching is emancipatory and liberating. Teaching allows students of color to break free from oppressive educational practices that are taught in the mainstream and allows students to see there is no single version of truth. Teaching destroys “the veil of presumed absolute authority from conceptions of scholarly truth typically taught in schools.” (Gay, 2010, p. 38).
6. Culturally responsive teaching is *humanistic*. It champions ideals of social justice and equips students with the ability to acquire knowledge of themselves and others and to respect humanity and its various groups. (Gay, 2018).

Consistent with these ideals, Averill et al. (2009) argued that in order for teachers to effectively engage in culturally responsive teaching, they need a deep understanding of mathematics. They need to value open relationships, cultural knowledge, and embrace a flexible approach to teaching the allows opportunities for implementing change. This can take place in numerous mathematical learning contexts and involves a responsive learning community. Perhaps, most important, is the ability to work within a cross-cultural teaching partnership (Nelson-Barber & Estrin, 1995). Having sociocultural consciousness (Villegas, 2002) is an important part of this process. Having affirming views of students from diverse backgrounds is paramount (Gay, 2002). Once one is able to see themselves as responsible for and capable of bringing about change to make schools more equitable, then can we understand how learners construct knowledge and are capable of promoting knowledge construction (Villegas, 2002).

**Funds of knowledge.** Strongly related to culturally sustaining pedagogy is the theory of funds of knowledge. Funds of knowledge can be defined as the incorporation of the knowledge and skills that have been acquired via history and though culture that are embedded within daily households and non-school related activities in families and the community (Aguirre & del Rosario Zavala, 2013; Moll, Amanti, Neff, & Gonzalez, 1992). Researchers have incorporated this theory when looking at how teachers are able to leverage their students’ funds of knowledge in a more formal educational, K-12, setting (McNeil, 2015; Moll et al., 1992; Moll & González, 2004). Although important, this body of work is not as relevant to the present study. Students in the current study are college students rather than K-12 students. While many college students
still live at home with their parents, many live on their own and establishing their own supportive communities that include friends as well as families.

**Culturally sustaining pedagogy.** Paris (2012) believes that both culturally relevant pedagogy and culturally responsive teaching do not go far enough. He takes issue with the terms “relevance” and “responsive” for they do not imply maintenance over time. These terms cannot “guarantee in stance or meaning that one goal of an educational program is to maintain heritage ways and to add value cultural and linguistic sharing across difference, to sustain and support bi- and multilingualism and bi- and multiculturalism” (p. 95). In effect, “[t]hey do not explicitly [imply] support [for] the linguistic and cultural dexterity and plurality necessary for success and access in our demographically changing U.S. and global schools and communities” (p. 95). It is possible to be relevant and responsive, but miss the big picture: continual engagement in appropriate practice. Paris declares that culturally sustaining pedagogy requires we “support young people in sustaining the cultural and linguistic competence of their communities while simultaneously offering access to dominant cultural competence’ (p. 95). The explicit goals are to support multiculturalism for both students and teachers, and seeks to sustain language, knowledge, and cultural pluralism.

**Comparing and Contrasting Competing Theories**

**Pedagogy vs. teaching.** Before we can begin to tease apart what makes one of these theories different from the other, we should first focus on the term “pedagogy” and the term “teaching” – for this will provide the groundwork for the differences. When talking about pedagogy, that refers to “the knowledge of generic principles of classroom organization and management” (Shulman, 1986, p. 14) while “teaching” refers to the practical part - the implementation of the educational process. In other words, pedagogy is a broader (more
theoretical) way of thinking about education, while teaching is the practical side of the coin. With that being said, at a broader level, I can make these claims: Gay’s work focuses more on teaching, which primarily seeks to influence competency and methods, for it describes what a teacher should be doing specifically in the classroom. Ladson-Billings (as well as Paris) focuses more so on pedagogy that primarily seeks to influence the overall attitudes and dispositions, that describes what a teacher may adopt when making decisions about what to plan, teach, and assess.

**Similarities and differences.** All three of these theories build upon existing work (see “culturally appropriate” (Au & Jordan, 1981), “culturally congruent” (Mohatt & Erickson, 1981), “culturally responsive” (Au, 2009; (Cazden & Leggett, 1981; Erickson & Mohatt, 1982; Lee, 1998), and “culturally compatible” (Jordan, 1985; Vogt, Jordan, & Tharp, 1987)). They are similar, in that, they all reference and have visions for teaching social justice within the context of classrooms. Using terminology from culturally responsive/relevant education (Aronson & Laughter, 2016; Dover, 2013), the components aligned in these three theories of social justice teachings can be synthesized as shown in Table 1. In Table 1, the rows have items highlighted based on their similarity to one another. Items that are not highlighted, but within the same row are similar, yes, however; they differ in that no other theory specifically address that concept with a major emphasis on it.

- **Academic Skills:** Culturally relevant pedagogy and culturally responsive teaching uses constructivist methods to bridge a gap between students’ cultures and the academic worlds in order to address their goals of long-term academic achievement and multidimensional and empowering teaching practices (CRT).

- **Critical Reflection and Cultural Competence:** By engaging students in critical reflection about their own culture and the cultures that are different than their own,
culturally relevant pedagogy encourages students to honor their own culture and seek access to others’. Culturally responsive teaching pushes teachers to tend to the entire child, not just the academic mind they are trying to mold. Culturally sustaining pedagogy encourages teachers to foster a sustained level of cultural and linguistic awareness.

- Culturally sustaining pedagogy distinguishes itself by aligning itself with multilingual and multiculturalism for students.

- **Critique Discourses of Power**: Culturally relevant pedagogy, culturally responsive teaching, and culturally sustaining pedagogy all argue that students need to have the knowledge and be exposed to critique systems that are in place and not to take them at face value. Through incorporating these real-life experiences into the classrooms, culturally relevant pedagogy affords the students an opportunity to utilize and develop a capacity be sociopolitical consciously. This also translates into culturally relevant pedagogy, as through these social justice teaching experiences (humanistic), students will be transformed into capable beings who build upon their prior strengths they come to the classroom with. Culturally sustaining pedagogy argues for the sustained knowledge and utilizing their cultural pluralism in order to critique these systems of power and oppression.

- Culturally relevant pedagogy specifically talks about itself as being an emancipatory form of education because it allows students to break free of “truths” that are normally taught in the context of schools.

- Again, culturally sustaining pedagogy explicitly states that students’ languages are a part of their culture and should be allowed to have that help sustain them and be an active part of their education.
• **Maintenance Over Time**: With Culturally Relevant Pedagogy 2.0, Ladson-Billings directly aligns her theory with Paris’ culturally sustaining pedagogy to emphasis the ever-shifting culture of students and realization that teachers will constantly have to reflect in their own practices.

**Table 1**

*Synthesizing Ladson-Billings, Gay, and Paris*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Culturally Relevant Pedagogy (Ladson-Billings)</th>
<th>Culturally Responsive Teaching (Gay)</th>
<th>Culturally Sustaining Pedagogy (Paris)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Skills</td>
<td>•Academic Achievement</td>
<td>•Multidimensional</td>
<td>(Assumed)</td>
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<tr>
<td></td>
<td></td>
<td>•Empowering</td>
<td></td>
</tr>
<tr>
<td>Critical Reflection and</td>
<td>•Cultural Competence</td>
<td>•Comprehensive and</td>
<td>•Sustaining Cultural and Linguistic</td>
</tr>
<tr>
<td>Cultural Competence</td>
<td></td>
<td>Inclusive</td>
<td>Competence</td>
</tr>
<tr>
<td>Critique Discourses of</td>
<td>•Sociopolitical Consciousness</td>
<td>•Transformative</td>
<td>•Support Multiculturalism</td>
</tr>
<tr>
<td>Power</td>
<td></td>
<td>•Humanistic</td>
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**Misuses of Culturally Relevant Pedagogy**

The intellectual father of the field of ethnomathematics, a field that maps indigenous cultures and mathematics, Ubiratan D’Ambrosio noted in his studies of elementary teachers that when they attempt to make a connection between culture and mathematics, it is often done in a trivial way or as a mere afterthought or as some curiosity exploration (2001). The activity is often deemed a “multicultural activity” that is usually done with regards to some semblance of the past or refers to cultures that are far removed from the students (D’Ambrosio, 2001). This happens due to the fact that teachers do “not [fully] understand how culture relates to children and their learning” (p. 308). Teachers and other stakeholders must realize that helping students understand their full potential in mathematics can be achieved by acknowledging the importance
of the cultures with which students personally identify. Students are influenced by this culture on a daily basis; their thoughts, their learning patterns, and even their emotions (Sanders, Haselden, & Moss, 2014). Teachers need to realize the importance of viewing their students as cultural beings, especially due to the “technological advances in communication, […] globalization and the concomitant increase in immigration that has altered previously stable demographic patterns, and changes in the role of women and the composition of the workforce” (Hodge & Cobb, 2016, p. 4). These changes in the landscape of who is gracing the classrooms all over American is drastically changing and it is doing so at a fast rate. Students need to be educated not only in academic mathematics, but they also need to know how diversity and culture influences the field of mathematics and how that has and could determine the many different ways that mathematics is used and is communicated across people in different places and countries, and also from subject to subject. When culturally relevant pedagogy is misused, its intended purposes are not met, thus the benefits are not realized by the students in the classroom. The following section reviews literature that has implemented culturally relevant mathematics pedagogy and the subsequent benefits seen due to such implementation.

**Culturally Relevant Pedagogy and Mathematics Education Literature**

As stated above, culturally relevant pedagogy is grounded upon three major dimensions, (1) academic achievement, (2) cultural competence, and (3) sociopolitical consciousness (Ladson-Billings, 1995b). Culturally relevant pedagogy has been utilized in various ways that encompass different aspects of these dimensions. For example, some researchers have focused on identity and achievement of students (English-Clarke, 2011; English-Clarke, Slaughter-Defoe, & Martin, 2012; Ensign, 2003; Enyedy & Mukhopadhyay, 2007; Leonard & Dantley, 2005; Sheppard, 2011), others address issues dealing with equity and excellence (Gutstein, Lipman,
Hernandez, & Reyes, 1997; Ladson-Billings & Tate, 1995; Lynn, 1999). Other researchers have examined curricula materials that are delivered to students, considering whether they address the whole child, and consider relationships students and teachers have with each other (Aronson & Laughter, 2016; Brown-Jeffy & Cooper, 2011; Matthews, Jones, & Parker, 2013; Milner IV, 2017; Morrison, Robbins, & Rose, 2008). Through a vast and extensive search of research articles that have claimed to utilize culturally relevant pedagogy, with special emphasis on empirical articles, I report the findings in this synthesis of the literature based on the three overarching dimensions. It needs to be said that although the findings are described in separate sections, the three dimensions cannot (and should not) be able to be so easily separated that they are distinct from each other, just as Ladson-Billings (1995a) argues. For example, “developing cultural competence is essential for academic success” (Hesch, 1999, p. 380).

**Academic Achievement**

Researchers have found students having made academic gains due to a variety of reasons when they have experienced culturally relevant pedagogy (Ladson-Billings & Tate, 1995). The luxury of high quality mathematics curriculum has, and is, often exclusionary in the sense that White students are disproportionately more likely to be represented in these classes (honors/accelerated and advanced placement courses) where Blacks, Latinos, and other people of color are funneled into lower level courses (Faulkner, Crossland, & Stiff, 2013; Stiff & Harvey, 1988). Researchers suggest that maintaining high expectations through culturally relevant pedagogy is possible and teachers are using innovate curricula materials and positioning themselves in ways to support and foster student understanding.

**Reshaping the curriculum.** The first theme involves teachers working with and creating curricula and various curricular activities for their students in order to support student success.
Teachers are able to do this through “intensive modeling, scaffolding, and clarification of the challenging curriculum” (Morrison et al., 2008, p. 435). For example, teachers use modeling with culturally relevant pedagogy in order for mathematics to be utilized in a classroom with true constructivist teaching practices (Anhalt, Staats, Cortez, & Civil, 2018). Modeling in the way Anhalt et al. (2018) implemented with high school students revolved around “students use their knowledge of an everyday situation to engage in cycles of mathematical inquiry” (p. 307). Anhalt et al. (2018) argue that "through rich mathematical modeling problems, students are able to work within the tenets of [culturally relevant pedagogy]: achieving through mathematics, building cultural self-awareness, and developing critical consciousness” (p. 326). Through the cycle of modeling, students had to make decisions, interpret, and validate their reasons after analyzing their results. It was through the students' background, lived experiences, and mathematical knowledge that students were better able to inform the cycle of modeling (Anhalt et al., 2018).

In a study by Rubel and Chu (2012), a conceptual model for teaching was used that centered itself around three dimensions (a) teaching mathematics for understanding -- mixing mathematical concepts, procedures, and facts and also engaging students in mathematical sense-making; (b) centering instruction on students' experiences; and (c) developing students' critical consciousness through mathematics (pp. 40-41). When looking at lessons these teachers implemented (planned and enacted), it was found that teachers who had high levels of one of the dimensions also had high levels in the others. Classrooms with strong instructional environments "consistently contained tasks of high level so cognitive demand and offered students the most varied modalities of participation in mathematics" (p. 50). In weaker classroom environments
students were disengaged and were prone to disruptions. These classes also "included negative intellectual support of students (by the teacher and by the other students) (p. 50)."

Teachers implemented culturally relevant pedagogy to aid in creating culturally relevant lessons while adhering to mandated standards and curricula in a study by Aguirre and del Rosario Zavala (2013). Through professional development where teachers used a rubric/tool, teachers were followed for the first years in a classroom to see how their lesson plans aligned with culturally relevant teaching practices. The teachers were able to critique mathematics lessons addressing issues such as mathematical thinking, language, culture, and social justice which “foster[ed] purposeful pedagogical dialogue and critical reflection” (p. 173). Implications of these findings suggest teachers were able to critically analyze (through self-reflection) the lessons they are offering within a specific day or an entire unit by looking at the various dimensions related to culturally relevant pedagogy. In order to maintain culturally relevant pedagogy, it begins with intentionally planning to do so, and looking at lesson plans is an integral part of promoting academic rigor amongst students.

**Integrating technology into mathematics curricula.** The second theme involves how integrating technology and mathematics provides for a powerful launching pad for interactive curricula that will get students engaged in high level mathematics. Through innovative curricula that utilized computers teachers are better able to engage students, maintain rigorous mathematics engagement, and promote learning (Ares, 2008; Eglash, Gilbert, Taylor, & Geier, 2013; Gilbert et al., 2008). Using virtual design and computer science software based on ethnomathematics and cultural themes, Eglash et al. (2013) showed that students at a Boys and Girls' Club found the materials helpful "and provided complementary coverage of the various dimensions of culturally [relevant] learning" (p. 647). Students were able to leverage their
vernacular (linguistic) and heritage culture with the mathematics in the computer simulated
design software with which they interacted. Through social creativity and ethnic exploration,
children from historically disempowered backgrounds were also able to connect to mathematics
and construct a healthy self-identity. Similarly, using a computer program (Gridlock PartSim) to
explore optimization in mathematics classroom (Ares, 2008). Students were able to engage in
discourse, use informal language to reason communicate mathematically. Teachers in this study
gave students the space to explore and construct their own knowledge though the use of
graphical representations. These representations connected with each other and to real world
phenomena (traffic grids of Rochester, NY where this study took place) which allowed students
to strategize at the individual and group level, and connect different levels of reasoning (Ares,
2008).

Similarly, Gilbert et al (2008) conducted a study of high school students who utilized a
game designed using culturally relevant principles to supplement mathematics learning. They
found that the game supported students academically on an algebra test and improved their views
and how they saw mathematics. This computer game was culturally relevant in that it "combined
culture, hip-hop lyrics, speech capabilities, and a 3D animation, game-like interface to enable
students in learning algebra" (Gilbert et al., 2008, p. 27). Overall, there was a significant positive
correlation between how students view the difficulty of mathematics as a subject and how they
thought the game was useful in helping them in mathematics. This relationship was extremely
strong for the male participants in this study. The results showed that students enjoyed these
culturally relevant-based lessons because the participants felt that the lessons were able to hold
their attention and keep them interested in the mathematics. Students reported they thought the
structure of the game was interesting. In particular, students really enjoyed the rap-lyrics that
were embedded throughout the simulation and they claimed that they wanted the mathematics that they were learning in classes to correlate with the real world. This game allowed students to see some connections and they appreciated the opportunity to do so (Gilbert et al., 2008).

**Building relationships between students, teachers, and community.** The third theme in academic achievement deals with the relationships that teachers have intentionally sought out with students, their parents, and their communities to create a positive learning environment in which students have access to more avenues for their success. Like Ladson-Billings research of successful teachers of African American students (Ladson-Billings, 1990, 2009), Gutiérrez (2000) also explored a mathematics department that was successful in getting African American students to persist in higher level mathematics courses. The teachers in this department often drew upon culturally relevant pedagogy principles by exploring the interests of students and creating classroom activities around it. These teachers made themselves available to students at atypical hours, such as before and/or after schools and during the weekends to help students. These teachers provided opportunities for their students to have autonomy over their learning by giving them assignments where they had choice in topics and that they could draw on knowledge that went beyond their textbooks (Gutiérrez, 2000).

In a study of elementary school teachers with success teaching classrooms with high African American student populations, Jackson (2013) found teachers utilized culturally relevant pedagogy. They had specific knowledge on how to teach African American students, build relationships with them, and help "African American students maintain their identities" (p. 11). A highly successful teacher, Ms. Finley was able to reach African-American students through her use of exemplifying culturally relevant pedagogy principles of building relationships and trust with her students, communicating with her students effectively, and having appropriate
mathematical knowledge to push her students (Bonner & Adams, 2012). Her approach in mathematics class was highly interactive and she was able to redirect and address students’ misunderstandings. She demonstrated a great deal of critical knowledge (Gutstein, 2006) used to empower her students as agents of social change. Her involvement as a community member allowed her to successfully communicate with students (mathematically and disciplinarily). She incorporated music in her class – meeting students where they were with “this cultural thing” (Bonner & Adams, 2012, p. 32). She constantly reflected and responded to students' feedback and revised her knowledge, communication styles, and relationships with students. This allowed her students to succeed in mathematics while some of her peers struggled in aiding their students to find academic success in the subject of mathematics.

**Seeing results through the numbers.** The last theme is centered around the quantitative results in the research literature related to academic achievement. The effect of teaching with culture has shown to have a substantial increase in self-confidence and self-efficacy; effectively replacing feelings of failure and alienation that is all too common with the subject of mathematics and students of color (Tate, 1995). I preface this theme by noting that few quantitative results tie student achievement to culturally relevant pedagogy, but there have been calls by researchers to do so (Sleeter, 2012). Sleeter (2012) charges mathematics researchers to fill the “clear need for evidence-based research that documents connections between [culturally relevant pedagogy] and student outcomes that include, but are not necessarily limited to, academic achievement” (p. 578). The aim of a study conducted by Enyedy and Mukhopadyay (2007) was to provide rich and engaging mathematics environment for urban high school students using principles of culturally relevant pedagogy. By using socially and personally relevant topics, students showed significant gains in mathematical ability that were also seen in
projects students created at the end of a summer program as measured on written pre and posttests by Enyedy and Mukhopadyay. The goals of the researchers were to create practices that helped in meaningful exploration of mathematics that was shaped and directed by students. Students used their own knowledge of their communities to engage and interact in meaningful ways utilizing mathematics as a tool for their endeavors. This study showed the "importance of a consistent and coherent set of norms and practices that balance and integrate the mathematical goals and the goals of [culturally relevant pedagogy]" (p. 168).

In another study, utilizing culturally relevant pedagogy in the classroom (Ensign, 2003), it was shown that students were more on task and they scored higher on unit tests for their class. Through student interviews, there was also evidence that students took higher interest in mathematics when they were able to engage and create problems that have relevance to their lives (Ensign, 2003). Research has also suggested that students tend to hold positive views of culturally relevant pedagogy mathematics instruction (Hubert, 2014). High school students in Hubert’s (2014) study experienced improved attitudes, increased interest, confidence and motivation. All the students in this study had positive attitudes towards learning mathematics when using a culturally relevant pedagogy approach. This was evident by a student who stated that the culturally relevant pedagogy "made the class feel so alive" (p. 329). On a pre-/post-test design, students, on average, showed significant increases, an entire letter grade, and students reported being confident to take their state exam assessment (Hubert, 2014).

Cultural Competence

What constitutes "relevant" information to students? That is the question that was addressed by Enyedy, Danish, and Fields (2011). They state that this process is an ongoing negotiation between what the students, themselves, find relevant in their personal lives and what
they find relevant in the classroom context. Engaging in culturally relevant pedagogy is a constant balance "between students' interests and the classroom version of mathematics” (p. 7). It occurs over time between students and teachers and will result in a meaningful experience to all involved. This legitimization of what will be accepted as "valuable" or "correct" provides students a high degree of power and self-confidence that will empower them to impact not only their academic lives, but also their local and global communities, at large (Enyedy et al., 2011). That is what researchers in this strand have clung to as they research culturally relevant pedagogy in schools, unearthing cultural competence on the way.

**Empowerment through language.** The first theme in the cultural competence dimension is empowerment through language. In classrooms, teachers are allowing students to use their native languages to complete classroom activities and as to elicit parental involvement (Brenner, 1998; Ramirez, McCollough, & Diaz, 2016). By allowing students to use their strengths as a starting point for instruction, teachers planned lessons and sequences of activities that allowed students to have initial positive encounters with the content before progressing to more challenging mathematics. These culturally relevant teachers encouraged students to use their native languages whenever possible whether the teacher knows the language or not (Brenner, 1998). This was another form of autonomy that teachers provided that went along with providing active and engaging learning and different forms of assessments.

In a study conducted by Cahnmann and Remillard (2002), they reported how a Puerto Rican teacher, Mrs. Arieto, used language in order connect with her students. She used that common thread she held with her students to get them to interact with mathematics and establish trust. She leveraged this shared language, culture, and low socioeconomic status (from a poor city in New York) to connect with and empower students in mathematics. In contrast, Ms.
Kitcher, a White middle-class teacher had problems connecting to her students because of her unwillingness to acknowledge race and culture in her classroom. She considered herself a "progressive" teacher and would acknowledge class and gender differences; however, she took a "colorblind" approach to her students, which made it tougher for her.

**Leveraging culture and community.** The second theme in this category is the utilization of bringing together students’ cultures they bring from home and their communities (that may include and go beyond language). This theme overlaps with the theory of funds of knowledge by focusing on bridging the gap between home and school (Aguirre & del Rosario Zavala, 2013). Utilizing the hobbies of students and their families has shown to increase interest and self-efficacy among students (Ensign, 2003; Enyedy & Mukhopadhyay, 2007; Fulton, 2009). In a study by Guha (2006), teachers who used counting methods from cultural traditions of their students found success in doing so. In some studies, teachers used known objects (personal) to the students, such as sea shells, dominoes, quilts and others to learn mathematics (Cahnmann & Remillard, 2002; Guha, 2006; Leonard, 2017). One group of teachers found success though connecting their mathematics classes to gardening (Civil & Khan, 2001). In this class, students were able to engage in “math talk” to make important connections. This was relevant to the students and Civil and Khan (2001) were able to involve not only students, but also their families and communities. The information that parents had to share and contribute about gardening, were valued and contributed to the success of the classroom. Students in this class outperformed students from previous classes on formal assessments.

Teachers also use music, specifically hip-hop, as a form of engagement with students and researchers have written about their successes for African American students (An, Tillman, & Paez, 2015; Bonner & Adams, 2012; Emdin, Adjapong, & Levy, 2016; Gholson & Martin,
For example, in a study conducted by Gholson and Martin, 2014, the researchers reported that Ms. Robinson's classroom of elementary Black girls deliberately created a classroom environment where she utilized a culturally relevant pedagogical method of teaching that included elements of such music and dance (Gholson & Martin, 2014). Results showed how that social networks are instrumental in shaping learning opportunities and the development of academic, mathematical, and racial identities of these girls and teachers can shape their classrooms with this knowledge.

By being aware of what students are familiar with and showing them how their everyday lives relate to mathematics teachers will encourage students to become more interested in mathematics and propel them to achieve (Langlie, 2008). In a study with high school teachers, Leonard, Napp, and Adeleke (2009) were able to infuse culturally relevant pedagogy-based activities in an afterschool program, The teachers found these activities extremely useful and they brought them to their classrooms. The teachers' initial beliefs about the nature of mathematics hindered their ability to see beyond high-stakes testing and school policy, but after the initial implantation of the activities in the afterschool programs, teachers bought in and really thought about how it connected with their own identities and their students' identities (situated in an 87% African American school). The culturally relevant pedagogy allowed student to develop their critical thinking abilities by providing an opportunity for students. Using culturally relevant pedagogy, this study shows that “teaching for cultural relevance is a complex enterprise" (Leonard et al., 2009, p. 19).

Preservice teachers engaging with students’ culture. This third and final theme revolves around preservice teachers using students’ culture inside their classrooms they are training in and with students they are working one-on-one with to enhance their learning.
Gutiérrez (2009) and Marta Civil (2006) argue for work to be done at the preservice teacher level in the area of changing the way they think about the nature of mathematics and educating future students. In order to take an "equity stance," these preservice teachers must understand that this work cannot solely be learned during their teacher-preparation years, "or through readings about the lives of “others” and/or their successful teachers, or curricular activities that expose a non-Western view of mathematics or a critical view onto the world" (Gutiérrez, 2009, p. 12). It involves knowing and learning about their students (which is a constant process), taking charge of the classroom and doing what is necessary in the best interests of the students they have, and teaching students not only about mathematics, but also building their self-esteem and their personal identities (Gutiérrez, 2009). Civil (Civil, 1989, 1993, 2006) has worked primarily in working-class, Latino communities to push for the shifting the focus of teachers and teacher preparatory programs to collectively focus on the complex and key stakeholders involved in education: parents, teachers, and students and on mathematics. She states that “if we are to address equity in mathematics education” this has to be a top priority (Civil, 2006).

Leonard and Dantley (2005) taught prospective teachers using a variety of strategies in order to expose these students to diversity and culturally relevant pedagogy. The teaching relied heavily on constructivist methods to get students learning by doing. Incorporating videos and multicultural literature books (within a mathematics course) was found to be the biggest aspect of helping students overcome their aversions towards talking about race and other sensitive topics (to them) in a mathematics classroom (Leonard & Dantley, 2005). Utilizing textbooks is an issue that preservice teachers struggled with when trying to tie in the tenets of culturally relevant pedagogy and mathematics texts. In a study by Leonard, Moore, and Brooks (2014), they found that a vast majority of their preservice teachers (89%) could select mathematically
rigorous and robust texts but only 28% could choose texts that were culturally relevant that were also contextual and mathematically rigorous and robust. Four preservice teachers were able to successfully integrate multicultural texts with mathematical tasks and use them to facilitate learning in early childhood and elementary classrooms with pairs or individual students. One preservice teacher was able to demonstrate all three tenets of culturally relevant teaching in a substantive way (Leonard, Moore, & Brooks, 2014).

Going beyond texts and looking at student engagement, one study examined how preservice teachers engage with students using culturally relevant pedagogy techniques to reinforce their learning (Sheppard, 2011). Sheppard (2011) found that given the opportunity, these preservice teachers incorporated the tenets of culturally relevant pedagogy by being sensitive to the details of each of their student's experiences. That allowed them to transform those experiences into teachable moments. These preservice teachers learned that students can perform at their best when allowed to incorporate aspects of themselves into their work. Given the opportunity, students may reveal their cultural identities through their work, while at the same time this provides "an excellent opportunity for teachers to get a glimpse of their students' current understanding[s]" (McCulloch, Marshall, & DeCuir-Gunby, 2009). Sheppard (2011) also states that instead of judging the students and condemning them for their lack of skills in certain areas, "[the preservice teachers] remained persistent in hopes of unearthing the Hidden or Un-Met Potential (HUMP) possessed by their students" (p. 261).

As shown through mathematics autobiographies, teachers have a profound impact on students, some of whom will become teachers themselves (McCulloch, Marshall, DeCuir-Gunby, & Caldwell, 2013). When students are exposed to a learning environment that they feel comfortable in, "relationships with [students], family, peers, and most importantly, teachers,
[can] be the most influential aspects” students need in order to succeed (p. 388). McCulloch et al. (2013) suggest that preservice teachers (especially at the secondary level) should read others and create mathematical autobiographies (an account of how they learned mathematics) because most of positive transitions to desire to become mathematics teachers happened within the later grades.

**Sociopolitical Consciousness**

Possibly the least addressed of the tenets of culturally relevant pedagogy, sociopolitical (or critical) consciousness, this section will show how researchers attempt to unveil the policies and practices that are happening in the world outside (and sometimes inside) the classrooms. William Tate (1995) stated that the benefits of this type of pedagogy are beneficial as students are able to pose their own questions as they relate to their communities and how they feel they are negatively impacted. This way, students are in charge of their own learning and it allows students “to see the world from the perspective of others” (Tate, 1995, p. 170). Students are able to incorporate the problems facing many African American communities to make mathematical learning more relevant to them as shown in this dimension.

**Power through the sociopolitical.** By addressing anti-racism and social justice issues through mathematics education, researchers are moving past sociocultural views in attempts to "espouse sociopolitical concepts and theories, highlighting identity and power at play” (Gutiérrez, 2013, p. 37), which brings us to the first theme of this section. Gutiérrez (2013) charges us to make transparent the realities that are plaguing us so that we can empower our students to rise beyond the current dynamics that are at play in mathematics education and in our society. Teachers have to continually be educated and attend professional development so that they can see their mathematics classrooms as a smaller part within a large social and political
history. They need support to challenge discourses that seek to instill inequality though the use of high-stakes standardized test scores as the only measure for learning. This involves developing more than just content knowledge or pedagogical content knowledge (Ball, Thames, & Phelps, 2008), "but also the political knowledge of mathematics, pedagogy, and learners, but also the political knowledge and experiences necessary to negotiate the system and develop working networks with other education who share their emancipatory visions" (Gutiérrez, 2013, p. 62).

During a series of professional development sessions in the Bahamas, teachers wanted to enhance their abilities to " (a) foster critical mathematical and critical consciousness, (b) build on informal mathematical and cultural knowledge; and (c) utilize empowerment orientations toward students’ culture" (Matthews, 2003, p. 61). The institute hoped to marry culturally relevant pedagogy with a heavier emphasis of social justice pedagogy (Gutstein et al., 1997) to reflect on the use of mathematics in schools and the world, explore enhancing algebraic mathematics instruction, and using students' cultures as a tool in mathematics class. Some teachers were more successful than others. The teachers who were successful relied on the relationships built between their students and themselves. Teachers also built on students’ mathematical and cultural knowledge simultaneously thought rich mathematics explorations. Through this, students’ critical thinking capabilities were expanded though mathematics, and connections to the government and other societal entities were investigated as context within their mathematics courses (Matthews, 2003).

**Social justice pedagogy in action.** This theme deals with teachers’ enactment of social justice within their classroom. Some teachers have found success in infusing project-based curriculum with culturally relevant pedagogy (Gutstein, 2003; Gutstein et al., 1997; Westheimer & Kahne, 1998). Lynn (1999) interviewed African American teachers of predominantly African
American students about their successful practices with this demographic. These teachers were sought out due to their liberative-styled instruction. These mostly elementary school teachers commented on the pervasive of racism in America (DeCuir & Dixson, 2004), the importance of cultural identity for African American students, and the intersection of class and race (Crenshaw, 1989, 1991). Aligning with culturally relevant pedagogy, this style of teaching (liberatory), according to Lynn (1999), consists of:

(a) teaching children about the importance of African culture [cultural competence];
(b) encouraging and supporting dialogue in the classroom [constructivist methods];
(c) engaging in daily self-affirmation exercises with students [cultural competence]; and
(d) actively and consistently resisting and challenging authorities who advocate practices that are hegemonic and counter-emancipatory [sociopolitical consciousness]. (p. 619)

Teachers can choose to see the connections between mathematics teaching and social justice in the form of activism (Gutstein et al., 1997). This study uncovered that teaching for social justice and using culturally relevant pedagogy is not removed from the standards. In fact, they overlap. Both social justice and teaching standards understand and advocate for teachers using students' cultural knowledge as platforms for instructional activities and requires a place for critical thinking. There is an important distinction that exists between thinking critically in mathematics (necessary for mathematical aptitude) and viewing knowledge critically in general (necessary for effective social change) (Gutstein, 2003; Gutstein et al., 1997). Teachers should (continue) to make connections between families in order to create and foster a sense of community in which students will see their culture in their work in order to build "a curriculum of empowerment and as a way to promote cultural excellence" (Gutstein et al., 1997, p. 733).
Counter-stories from culturally relevant pedagogy via social justice. The use of counter-stories is a prevalent way that connections to creating a sociopolitical consciousness that researchers have used to show empowerment with students who receive culturally relevant pedagogy instruction. A counter-narrative becomes a counter-story when it contains a representation of a dominant (cultural) narrative that provides reasonable background. It also has to be enough to contradict said narrative that also allows a person to push towards a reality that is free from the original negative narrative (Terry, 2011, p. 30). This is exactly what Terry (2011) was able to implement with his high school Black male mathematics students located from various high school students across south Los Angeles. They were able to use the idea of the counter-stories and mathematics in order to make sense of the world around them. They pulled in news stories and reports from the Los Angeles County Police Department (LAPD) that provided graphs and other dubious informational pieces that the students were able to comb through and analyze. The narrative being run here is that crime rates have dropped dramatically over the years due to an increase presence in places of LAPD officers, and in order to drop crime even lower, an increase in trash collection fees must be maintained in order to fund increased presence. After looking at the data more closely, the students came up with the counterstory that the possibility of the decline in crime rates were not actually due to the ratio of police officers in urban Los Angeles and possibly it was some other undiscovered (combination of) mediating factor(s). After looking at the data and making statistical calculations, the students found that the ratio had, for all intents and purposes, remained the same at around 433 citizens for every one police officer (currently 434:1). They used other data sets, as well, in order to look at other narratives that could possibly be rebutted including data from the number of Black males aged 18-35 in California state universities and in California state prisons. This data was culturally
relevant to the students because they witnessed and had various encounters with LAPD officers and people aged 18-35 who were either in college or in prison. The context was able to hold and keep their attention for the purpose of using mathematics in order to sift through data and look for the counter-stories in order to counter the stories that were being told in the media about people who look like they do. The stories are real to the students, and when the stories become real, the students become invested. Terry (2011) summarized from his work that mathematics educators have to step back in order to see the bigger picture and damages that sticking to traditional curricula is causing certain groups of students to miss out on a valuable mathematics education. Educators “have reason to believe that those students who are regularly marginalized within our traditional approaches to teaching and learning mathematics might respond—both favorably and critically” (p. 44) to the non-traditional approaches of cultural relevant mathematical materials and context.

Students did indeed begin to examine the inequalities not only in mathematics, but also in other areas of life in a multi-year ethnographic study by Gutstein (2003). Gutstein (2003) implemented culturally relevant themed lessons and activities during a two-year period at an urban, Latino public school in Chicago, IL. He taught using a hybrid of resources from the standards-based curriculum Mathematics in Context and he also supplanted additional resources with 17 real-world mathematics projects because while Mathematics in Context did illustrate some real-life connections, most of it did not connect to students’ lives nor their experiences, which was his main focus of teaching these students to begin with; for “no single curriculum [can] be relevant to all students, and a real-life context is not necessarily a meaningful one” (p. 63). Through his use of adding culturally relevant material to students’ mathematical awareness, he was able to reach these students like no teacher has ever done before for them. Once these
students were able to see how the mathematics that was being taught connected to their daily lives, they began to understand not only the content, but also how institutional forces shape their lives – as most students were first generation American with 98% of the school population classified as low-income, and who recently immigrated from other Spanish-speaking countries; mostly Mexico (Gutstein, 2003).

The driving forces behind the mathematics were notions of power, inequitable resources, and disparate opportunities of different groups of people in order to understand blatant discrimination based on gender, class, race, language, and other forms of differences (Gutstein, 2003). Students looked at the media and its portrayal on matters and compared that with actual data in order to make connections between things that are going on in the world, socially, and their individual lives. They did this with real-world projects where mathematics was the analytical tool. This often happened though igniting discussions that did not seem math-related at first, but then it transformed into situations that required an exploration of mathematical concepts, which he called “going beyond the mathematics” (p. 45). As these students’ mathematical ability increased, so did their understandings of how society worked as well (Gutstein, 2003).

Culturally relevant pedagogy "builds on and values the cultural experiences and knowledge of all students regardless of whether they are represented by dominant or non-dominant cultural systems and empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart their knowledge, skills, and attitudes in the pedagogical work in schools" (Rosa & Orey, 2010, p. 26). In the next section, I discuss challenges researchers have encountered and some concerns and issues they have brought up during their research endeavors.
Challenges and Concerns

Challenges with culturally relevant pedagogy. No theory is implementation-proof as is, and even if implemented with the best intentions, issues arise when dealing with people. Researchers have certainly pointed to some concerns with the implementation of culturally relevant pedagogy. One study highlights the difficulties of integrating all three tenets of culturally relevant pedagogy (Ye, Varelas, & Guajardo, 2011). For Ye et al. (2011), the sociopolitical consciousness was the toughest dimension to address. In a study looking at two graduate students and their interactions with high school mathematics students, they had troubles because the students with whom they were working lacked basic skills and the prerequisite knowledge in order to independently engage in inquiry without a lot of guidance. Some researchers also comment on how it is more difficult to connect abstract mathematical concepts to cultural knowledge and attempting to do so may oversimplify the content, resulting in “watered-down” mathematics, or oversimplifying the cultural relevance (Anhalt et al., 2018; Cahnmann & Remillard, 2002).

Concerns that teachers bring up with teaching culturally relevant pedagogy is that it involves risk, time, and self-reflection, all of which can often lead to teacher attrition and burn out (Esposito & Swain, 2009). Prescribed or scripted curricula leaves very little room for critical thinking skills among students. As a result, it perpetuates continuing notions of how students should think (Matthews, 2008). One of the goals for culturally relevant pedagogy is to help students become critical thinkers and to think for themselves. They could see themselves being reprimanded or even fired for challenging the status quo (Hernandez, Morales, & Shroyer, 2013; Matthews, 2008).
Within a larger project, Nurturing Mathematics Dreamkeepers, Marshall, DeCuir-Gunby, and McCulloch (2012) wrote of a cautionary situation for researchers who seek to engage in professional development with teachers for culturally relevant pedagogy. Aisha (the case study focus) showed the "requisite dispositions" (p. 9) that were clearly aligned with an orientation to be receptive to culturally relevant pedagogy. Being a faithful participant to the professional development activities over a two-year period, it was found that this did not translate over into her videotaped classrooms sessions. Instead of aligning her instructional practices with the needs of her diverse students, she implemented lessons that showed little to no alignment with tenets of culturally relevant pedagogy. Even further, her "ability to reflect critically and thoughtfully on the reasons behind her pedagogy [were gone]" (p. 13). Possible reasons for this contraction in terms of disposition and enactment given by the researchers were schools with too many high stakes tests and the teachers ability and comfortability with the content area (Marshall, DeCuir-Gunby, & McCulloch, 2012). However; "the negative implications associated with teaching for social justice are complex, [but] attainment of social justice, however, is well worth the struggle" (Esposito & Swain, 2009, p. 46).

Moving Beyond the Challenges

Culturally relevant pedagogy has been utilized in various ways in the research, all centered around how students were able to or teachers allowed through their instruction the goals/dimensions of culturally relevant pedagogy. Teachers play a huge role in shaping how students are able to interact with mathematics; if it will be a static, procedural entity with little connections to the “real world” or a tool that can be used to help explain the world and fight for social justice. Classroom teachers must be able to think critically about the instruction they are bringing for to their students (Boon & Lewthwaite, 2015; Sanders et al., 2014; Wager, 2014).
According to Sanders et al. (2014), this begins with teachers becoming “self-aware, reflective, and understanding of the future populations of children that they will be held accountable for in the very near future” (p. 184). If teachers within their early years want to succeed in diverse schools, teacher education programs must better prepare “monocultural teachers to teach in multicultural classrooms” (Smolen, Colville-Hall, Liang, & Donald, 2006, p. 47). This happens through self-awareness and through reflection. Through these practices, teachers will garner a level of participation which will allow them to notice inequitable structures within their mathematics classrooms and contemplate how to change them (Wager, 2014).

Chapter Summary

Increasing mathematical knowledge and ability is certainly a goal of this body of research as well as affording historically marginalized students the opportunity to succeed. If students see no links between the subject they are trying to learn and their lives and future goals, then they will not respond to it. Sticking to the status quo and continuing not to teach mathematics with a cultural perspective will continue to exclude peoples from cultures from outside the dominant majority because they just simply will not be interested in it (Nasir et al., 2008). As Herzig (2005) states, “some individuals may reject mathematics not out of a sense of choice but because they feel that mathematics has rejected them” (p. 253). Thus, the transition to the inclusion of these practices can be enhanced through listening and learning from students and other adults who are invested in making the students’ learning environments productive and conductive to developing students’ identities of themselves and the world.

The driving force behind much of culturally relevant pedagogy literature reviewed in this literature review is summed up by Martin (1997): “[e]xposing the links between mathematics and social [awareness] should not be seen as a threat to “[academic] mathematics” but rather as a
threat to the groups that reap without scrutiny the greatest material and ideological benefits from an allegedly value-free mathematics” (p. 169). Offering students proven and valuable methods to a new view on mathematics should not come to a treat to anyone, for enriching the mathematical educational experience for students of varying backgrounds that do not reflect that of what is shown on posters and in textbooks through the use of culturally relevant teaching has positive effects on those students (Ascher, 1991). It can be complicated or hard for some teachers, especially if their cultural backgrounds differ from their students (Causey, Thomas, & J. Armento, 2000; Gutstein, 2003). This can be minimized through listening and learning from students and other adults who are invested in making the students learning environments productive and conductive to developing students’ identities of themselves and the world (Melnick & Zeichner, 1998).

This line of emancipatory research charges educators to meet their students where they are and try to reach them even if they are not running towards it. Culturally relevant pedagogy requires a fresh new take upon preconceived ideas that we hold about our students and mathematics in general (Padron, Waxman, & Rivera, 2002). All stakeholders must be involved in this change in order for it to be as effective on all levels as possible.

My aim in this study is to contribute to the mathematics education literature on culturally relevant pedagogy. As most of the research in this area has taken place at the elementary, middle, and high school grade levels (with smaller emphasis towards the higher grades), I will be focusing on collegiate mathematics. By doing this, I hope to reveal ways to help professors and instructors better reach their students, which could have the effects of decreased failure rates in introductory mathematics courses and increased self-efficacy for students. I also hope to show the use of self-evaluative tool for teachers to reflect on their own practices and call for
mathematics teacher development programs to include these practices into the curriculum for their participants.
CHAPTER 3: METHODOLOGY

As seen in the literature review, culturally relevant pedagogy has been used in a variety of mathematics classrooms; however, not as often at the collegiate level for the subject, even less so at the introductory mathematics level. In an attempt to fill this gap in the literature, the following research questions are proposed to guide this study:

1. What effect does culturally relevant pedagogy have on student achievement in a college algebra course offered at a historically Black university?
2. How are student views about mathematics affected in a course centered around culturally relevant pedagogy?
3. How do students enrolled in a college algebra course at a historically Black university define and describe their culture and their experiences with lessons designed to be culturally relevant?
4. How are college algebra students able to critique discourses of power using mathematics as a tool?

The research questions were purposefully formed and arranged to coincide with Ladson-Billings’ (1995b, 2014) theory of culturally relevant pedagogy. Research questions one and two align with academic achievement (how students view the subject of mathematics and students’ abilities to succeed in a class based on culturally relevant principles). Research question three aligns with cultural competence focusing on how students view themselves across the span of a course that is designed to help build their self-efficacy and views about themselves as a learner of mathematics. Research question four aligns itself with sociopolitical consciousness and how students are able to mathematize problematic situations to better understand what is going on
around them (both locally and globally), after participating in a class that is designed to help them develop and utilize these skills.

**Mixed Methods Definition and Design**

In an attempt to answer the research questions, a mixed methodological approach was utilized. Mixed methods research can be defined as “a research design (or methodology) in which the researcher collects, analyzes, and mixes (integrates or connects) both quantitative and qualitative data in a single study…” (R. B. Johnson, Onwuegbuzie, & Turner, 2007). This was the most appropriate approach to this study because it allowed for the exploration through a detailed, in-depth data collection involving multiple sources of information. Further, this design allowed me to answer the research questions using a variety of approaches in data collection and allowed me to see how this information influenced students’ feelings about mathematics. It allowed me to collect and analyze both qualitative and quantitative data by integrating these two forms of data (Creswell & Plano Clark, 2018). Specifically, I utilized an embedded (QUAN(qual)) quasi-experimental mixed methods design, in which qualitative data was collected within a traditional quantitative design (DeCuir-Gunby & Schultz, 2017). The research diagram of this study can be found in Figure 1 below.

Quantitatively, links between culturally relevant pedagogy, student achievement, and self-efficacy were examined. Using different types of analysis, I connected these constructs to focus on linking the knowledge with empowerment. Including a qualitative component is essential to “look beyond the numbers” in order to gain a fuller understanding of how the context of this course links with the experiences of the participants. Integrating the qualitative component with the quantitative analysis aligns itself with culturally relevant pedagogy and its values of promoting academic success, celebrating the cultural aspects of minoritized students,
and unveiling the connections between the sociopolitical and students’ lives through the use of mathematics.

**Figure 1.** Research diagram of dissertation study.
Experimental Section

In accordance to the three paradigms of culturally relevant pedagogy (Ladson-Billings, 1995b, 2014), four lessons were developed that incorporated these dimensions. The course was divided into five units: (1) Numbers and Their Properties, (2) Linear and Quadratic Equations, (3) Graphs of Functions, (4) Higher Degree Polynomials, and (5) Exponential and Logarithmic Functions. The four lessons were incorporated into the last three units. These lessons (not published in the Appendices, but available upon request from the author) provided students with a problem statement in which they had multiple opportunities to explore and create visual representations and vocal arguments of proposed support or denial of the statements using a data sets, mathematical manipulations, and information gleaned from websites containing information given to them by the instructor. Students also had the option and were encouraged to utilize other sources of data in order to fulfill the requirements of these assignments, frequently using their prior knowledge and past experiences of various topics in issues in society.

These lessons were intentionally developed with culturally relevant pedagogy and the population of the students in this course during this specific semester. These lessons were rated using Matthews, Jones, and Parker’s (2013) Culturally Relevant Cognitively Demanding (2011) task rubric (see Appendix D), which will be described in detail later in this chapter, for it informed a number of research instruments.

Intervention lesson three, for example, was entitled “How Do Poor People Bank? – An Exploration of Interest.” This lesson, adapted from Jonathan Osler (2007) via the RadicalMath.org website, had the mathematical objective to get students to explore and use exponential functions to model a real-world scenario. Students were introduced to the
mathematical topics of simple interest, compound interest and continuously compound interest formulae.

This lesson aligns with the theory of culturally relevant pedagogy because it contains components from all three tenets of culturally relevant pedagogy: (1) Academic Achievement, (2) Cultural Competence, and (3) Sociopolitical Consciousness. Specific alignment details can be found below. Details of all the other lessons and their relationship to the tenets of culturally relevant pedagogy can be found in Table 2

(1) Academic Achievement

Students learned essential, un-watered-down mathematics that they needed to progress through the unit and to be successful on their assessments. This lesson also thought towards the long-term goals and not just the short term (Ladson-Billings, 2006b) by showing students how their future/current student loans, car loans, house loans, all the way to sales tax is being calculated and affords them the knowledge to calculate these numbers for themselves.

(2) Cultural competence

This lesson was taught to a very diverse group of students who had various levels of knowledge associated with this topic. Although acknowledging that this lesson did not apply to each and every student (as no one topic will), but for the majority of students this lesson was timely and relevant since the vast majority of students on the campus receive Federal student loans (79%) (National Center for Education Statistics, 2017). Even students who do not receive these loans, they are offered them. Students are also consumers in the sense where they deal with sales tax and loans for cars and other similar topics where money is of concern. Students received the information that allowed them access to the information that enabled them “to have
a chance of improving their socioeconomic status and making informed decisions about the lives they wish to lead” (Ladson-Billings, 2006b, p. 36).

(3) Sociopolitical Consciousness

The sociopolitical objective of this lesson was to get students to think about the cyclic nature of poverty. Specifically, what we were investigating had to do with the difference in banking systems and principles used by wealthy and poor people. The essential questions we answered were: (i) How do poor people bank? and what financial systems do they use? (ii) Why do poor people rely so heavily on expensive financial systems? and (iii) What are the financial costs of using these methods to bank? Students had the opportunity to individually reflect and discuss with small and large groups the implications from what was learned about this information.
### Table 2

**Intervention Lessons and their Alignment with Culturally Relevant Pedagogy**

<table>
<thead>
<tr>
<th>Mathematical Objective</th>
<th>1</th>
<th>2</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 3: Functions and Their Graphs</td>
<td>Unit 4: Polynomial and Rational Functions</td>
<td>Unit 5: Exponential and Logarithmic Functions</td>
<td></td>
</tr>
<tr>
<td>Lesson: Linear Functions and Their Graphs (graphing linear equations in slope-intercept and point-slope form)</td>
<td>Lesson: Quadratic Functions (graphing and modeling quadratic functions)</td>
<td>Lesson: Exponential Functions</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Guiding Question</th>
<th>1</th>
<th>2</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>What does incarceration look like in this county and the United States? Does race play a role in incarceration?</td>
<td>How are sexually transmitted diseases and cuffing season related to each other?</td>
<td>How is the population of the United States changing?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Academic Achievement</th>
<th>1</th>
<th>2</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students learn foundations of graphing linear equations, a skill needed throughout the rest of the semester. They learn this using real incarceration data. This is also where students begin to model real-world information using mathematics.</td>
<td>Students learn how to model quadratic data with equations using technology. Students also use profit/revenue equations and link these quadratic representations using equations, tables, and graphs.</td>
<td>Students learn how logarithms are an extension of exponential functions and how a logarithmic scale is beneficial in situations involving large numbers. Students also connect these ideas of large numbers in relation to population growth.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cultural Competence</th>
<th>1</th>
<th>2</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data comes from real data sources and is related to the race of the students in the classroom. Some of the students have had experiences with people who are incarcerated and are knowledgeable about the criminal justice system.</td>
<td>Data is related and relevant for college students who are sexually active and has them think about their decisions. Furthermore, the term &quot;cuffing season&quot; is one unique to the African-American culture and one that is definitely known at an HBCU.</td>
<td>Students explore how the population of different races are growing (or decaying) using real-world data. Students have the opportunity to model the growth rates for different races.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sociopolitical Consciousness</th>
<th>1</th>
<th>2</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students are asked to think about the guiding questions and to use the data and their past experiences to think critically about the issue at hand.</td>
<td>Students are asked to think about a national issue/crisis and use data to help in their understandings. Students are also asked to formulate warnings and advocate for smarter practices for incoming first-year students.</td>
<td>Students use this data about the growth of minority populations in America and what that means for the future of America.</td>
<td></td>
</tr>
</tbody>
</table>
Control Section

The control also had lessons that were given on these “intervention days,” in which lessons were designed with effective mathematics teaching practices in mind (Smith & Stein, 1998; Stein, Smith, Henningsen, & Silver, 2009). These lessons utilized tasks that allowed students to:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.

These “mathematical practices” represent what students are doing while they are learning mathematics. These tasks can be classified as cognitively high demanding tasks because they allow students to use procedures with connections and students are “doing mathematics” (Stein, Smith, Henningsen, & Silver, 2009).

An example of a lesson that students experienced was implemented during unit five: applications of logarithms and exponential growth/decay. This lesson focused on the applicability of logarithms and exponential functions in the real world. Students first learn what logarithms are and then explore some applications of them, such as with earthquakes and the
representation of large numbers. Students, then are led to a discussion about global population growth and projected models, where they use exponential functions to explore.

This lesson provides students many opportunities to do mathematics and make connections to the procedures they must learn in a college algebra mathematics course. Students are able to participate in most, if not all, of the eight mathematical practices above. This lesson is missing the key component of cultural relevant pedagogy, the infusion of meaningful cultural context into this lesson. This lesson could potentially be modified to be culturally relevant if it allowed students to explore the population growth rates of certain races within America, as the unit five lesson does in the experimental section. This lesson could also be modified to focus on issues of social justice, where students explore the global population distribution in conjunction with wealth. These discussions could potentially come up when exploring population growth in the control class. However, as reported in Table 6, this, and all other lessons for this control class, remained in high fidelity to the lesson plans (sans cultural relevance).

**Setting and Participants**

**Context**

This study took place at a large historically Black college/university (HBCU) located in the Southeastern United States during the Fall 2018 semester. HBCU’s are a federal term given to colleges and universities that had as their primary mission the education of Black and African-American students before the year 1964. This qualified these colleges and universities for “special funds” that would allow these institutions to improve their “instructional capacity” (Wooten, 2015, pp. 37–38). Given the focus on culturally relevant pedagogy, the context of this study is highly important. Culturally relevant pedagogy was designed to address the needs of minority students, with special emphasis on African-American students because the needs of
these students were not being met (Ladson-Billings, 1995a). With evidence that says these students still continue to face numerous barriers for them to be successful in mathematics courses (Saxe & Braddy, 2015), I intentionally choose a population of students who could benefit from improved teaching methods. The location of the study, at an HBCU, was intentional and allowed for higher numbers of minority students, especially African-American students, to be included in this study.

**Course**

Students enrolled in one of two sections of a College Algebra and Trigonometry I, a course taught by an instructor at Bernard St. Stephen State University (pseudonym) were asked to participate in this study. This course has been and is currently predominantly taught using methods that would be classified as traditional and procedural. This developmental course is foundational and paramount to a students’ success if they are in a major that requires them to take additional mathematics courses, especially those that require up to calculus. For students who do not need to take any additional mathematics courses after this introductory course (which comprises an overwhelming majority of students who take this class), this course is seen as a barrier to graduation for students must attain at least a grade of at least C in order to successfully consider this graduation requirement at Bernard St. Stephen State University, and at the majority of colleges and universities in America (Ganter & Barker, 2004; Van Dyken, 2016).

This course was chosen because certain aspects of it lend itself well to culturally relevant pedagogy. The content can be delivered using varying methods other than direct lecture that would allow students to see the mathematics being used in real world contexts and situations that students could possibly relate to in order to create a more holistic and realistic learning
environment; one that attends to the “whole child” (Aronson & Laughter, 2016; Brown-Jeffy & Cooper, 2011).

The two sections were taught by the researcher with one section serving as a control group (the course not receiving lessons based on culturally relevant pedagogy; yet designed lessons that good mathematical practices) and the other the experimental (intervention) group (the course where students received mathematical lessons based on the principles of culturally relevant pedagogy). At the beginning of the course, all students (in both the control group and experimental group) were asked to complete the pre-test and pre-surveys as a part of normal classroom activities. Once approval was received from the Institutional Review Boards (IRB), students were asked if their scores from their pre- and post-test and surveys and all other academic measures, including journal reflections, could be used for the purposes for this research project. Only the experimental group was asked to complete journal reflections and participate in semi-structured interviews.

To protect the delicate balance of power between teacher and student, the informed consent forms for the experimental and control groups were not looked at until the end of the semester after all grades were finalized, turned in, and published by Bernard St. Stephen State University, per stipulations from the two institutions’ IRBs. Students were asked to either sign or not sign the consent forms and return them to the instructor. In addition, the interviews were not scheduled until after the semester had ended and grades were finalized and published. Agreeing participants in the experimental course completed an informed consent form (see Appendix A), while students in the control group received a different consent form (see Appendix B). Students from the experimental group signed and received an additional consent form if they were
selected and participated in the semi-structure interview (see Appendix C). Extra hard copies of all informed consent forms were given to students at the time of signing.

Participants

Each college algebra course at Bernard St. Stephen State University typically has between 25-35 students. Both experimental and control groups initially began with 32 students enrolled. Table 3 shows the number of students who agreed to have their responses used in this dissertation study and some demographic information about them (as reported by them on one of their surveys, the demographic questionnaire). An overwhelming majority of the students in both sections of the course were African-American (96% in experimental section, 92% in control section). Most of the students were also female (76% experimental, 58% control).

Table 3
Participants by Race and Gender

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>African American</th>
<th>Bi-racial*</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>18</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td>72%</td>
<td>4%</td>
<td>76%</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>24%</td>
<td>0%</td>
<td>24%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>96%</td>
<td>4%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control Group</th>
<th>African American</th>
<th>Bi-racial*</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>13</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>54%</td>
<td>4%</td>
<td>58%</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>9</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>38%</td>
<td>4%</td>
<td>42%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>92%</td>
<td>8%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

*Note: All bi-racial participants were (self-reported) half-African-American and half-White.

Experimental Group. This dissertation focuses primarily on the experimental section of the course; that is, the students who received the intervention lessons, and tracks the experiences of these students throughout the duration of the study. It is important, therefore; to have a closer
look at the students within this section beyond what has already been presented thus far. Table 4 shows the majors and year classification of the students in the experimental group. Of the 25 students in the experimental section, 21 identified as first-year students, three as a sophomore, and one as a junior. Of these students, a large number of students were majoring in either Accounting/Business Administration (36%), a Health Care-related pathway, such as Biology (Pre-Med) or Nursing (32%), or some major within the College of Education: such as Early Childhood Education, Elementary Education, or Physical Education (20%).

Table 4

<table>
<thead>
<tr>
<th>Major</th>
<th>First Year</th>
<th>Sophomore</th>
<th>Junior</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology (Pre-Med)</td>
<td>4</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Criminal Justice</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Education</td>
<td>4</td>
<td>1</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Nursing</td>
<td>4</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Social Work</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Sports Medicine</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21</strong></td>
<td><strong>3</strong></td>
<td><strong>1</strong></td>
<td><strong>25</strong></td>
</tr>
</tbody>
</table>

The average age for students within this course (at the time of the survey) was 19. Two of the participants were retaking this course for a second time, having earned D’s the previous semester in the course. It is important to reiterate a point made earlier in this section that grades of C or better in this course are considered “passing” and thus acceptable for this course counting towards one’s major course of study. One of the students in this group also had to take Introductory College Algebra, an entry level to the entry level mathematics courses offered at Bernard St. Stephen State University. For all other students, this was their first time taking a mathematics course at this university.
The course taught by the researcher that was the course deemed as the “experimental course” was chosen randomly before the official semester began. It is important that this course be chosen randomly due to this being a quasi-experimental study and to avoid any bias towards the students in either the experimental or the control group.

**Interview participants.** A total of eight students agreed to participate in the semi-structure student interviews (see Table 5). The student sample that was selected to participate self-identified as either all African-American (six females and 1 male) or of mixed heritage (one female, half-African-American and half-White). All these students were first-year students with one non-traditional student (who did not come directly to Bernard St. Stephen State University directly from a high school). The age of these participants was between 18 and 19, except for the non-traditional student who was 36 at the time of the study.

**Table 5**

**Interview Participants Information**

<table>
<thead>
<tr>
<th>Name (Pseudonym)</th>
<th>Race</th>
<th>Gender</th>
<th>Age</th>
<th>Year</th>
<th>Major</th>
<th>Final Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiffany</td>
<td>Black</td>
<td>Female</td>
<td>18</td>
<td>First Year</td>
<td>Nursing</td>
<td>A</td>
</tr>
<tr>
<td>Asia-La'Rae</td>
<td>Black</td>
<td>Female</td>
<td>18</td>
<td>First Year</td>
<td>Nursing</td>
<td>A</td>
</tr>
<tr>
<td>Pamela</td>
<td>Black</td>
<td>Female</td>
<td>18</td>
<td>First Year</td>
<td>Elementary Education</td>
<td>A</td>
</tr>
<tr>
<td>Matthew</td>
<td>Black</td>
<td>Male</td>
<td>18</td>
<td>First Year</td>
<td>Business Administration</td>
<td>A</td>
</tr>
<tr>
<td>Ahshante</td>
<td>Black</td>
<td>Female</td>
<td>18</td>
<td>First Year</td>
<td>Social Work</td>
<td>B</td>
</tr>
<tr>
<td>Lindsey</td>
<td>Black/White</td>
<td>Female</td>
<td>18</td>
<td>First Year</td>
<td>Nursing</td>
<td>B</td>
</tr>
<tr>
<td>Jamie</td>
<td>Black</td>
<td>Female</td>
<td>18</td>
<td>First Year</td>
<td>Business Administration</td>
<td>B</td>
</tr>
<tr>
<td>Kanisha</td>
<td>Black</td>
<td>Female</td>
<td>38</td>
<td>Junior</td>
<td>Business Administration</td>
<td>C</td>
</tr>
</tbody>
</table>
Data Collection

Instruments

Several instruments were used to answer my research questions. To address the quantitative research components, students’ course assessments and their final grades were used and participants were asked to complete a demographic questionnaire, a subset of questions from the Precalculus Concept Inventory (Carlson, Oehrtman, & Engelke, 2010), the Views About Mathematics Survey (Carlson, Buskirk, & Halloun, 1998), and a subset of questions from the Youth Survey on Race and Mathematics (English-Clarke, 2011; English-Clarke et al., 2012). For the qualitative components of this research study, I used a mathematics reflection journal, a semistructured interview, and video recordings of both the experimental and control groups’ lessons.

Course assessments and final grades. Data collection included scores from all five course assessments and students’ final grades. All course assessments were completed and graded automatically online on a computer via a popular college mathematics course management system: Pearson’s MyMathLab, that is widely used in service-level courses at Bernard St. Stephen State University and many institutions nation-wide. Student’s final grades were calculated using a weighted mean of the following components: 20 homework assignments (20%), eight quizzes (20%), five unit tests (40%), and a cumulative final exam (20%).

Each test, including the final exam, contained 20 questions that were weighted equally; created by a group of professors whom all teacher this college algebra course at Bernard St. Stephen State University, including the researcher. Questions on each exam contained mostly constructed-response with some multiple-choice items in which students had 60-75 minutes to complete via Pearson’s MyMathLab. Example items from each type can be found in Figure 2.
Sample test items from Unit 4 (Polynomials and Rational Functions) test. Although not an ideal mathematical assessment practice, this grading system did reduce any bias towards either class of students from the instructor in grading practices, for the program graded each students’ response.

3. Consider the function \( f(x) = 3x^2 - 30x - 1 \).
   a. Determine, without graphing, whether the function has a minimum value or a maximum value.
   b. Find the minimum or maximum value and determine where it occurs.
   c. Identify the function’s domain and its range.

   a. The function has a (1) __________ value.
   b. The minimum/maximum value is __________. It occurs at \( x = \) __________.
   c. The domain of \( f \) is __________. (Type your answer in interval notation.)

   The range of \( f \) is __________. (Type your answer in interval notation.)
   (1) O maximum
       O minimum

6. Find the vertical asymptotes, if any, and the values of \( x \) corresponding to holes, if any, of the graph of the rational function.

   \[ h(x) = \frac{x}{x(x - 3)} \]

   Select the correct choice below and, if necessary, fill in the answer box to complete your choice. (Type an equation. Use commas to separate answers as needed.)

   O A. There are no vertical asymptotes but there is(are) hole(s) corresponding to __________.
   O B. The vertical asymptote(s) is(are) __________. There are no holes.
   O C. The vertical asymptote(s) is(are) __________ and hole(s) corresponding to __________.
   O D. There are no discontinuities.

Figure 2. Sample test items from Unit 4 (Polynomials and Rational Functions) test.

Demographics questionnaire. The demographics questionnaire (see Appendix E) included questions regarding students’ age, race/ethnicity, education classification, enrollment status, and current grade point average. Additional questions were also asked in order to document students’ current and past success in mathematics courses. This questionnaire also contained a few questions that asked students about their future plans to take other mathematics courses. These questions were useful during analysis for they allowed another potential measure
on how students’ self-efficacy has been built as a result of the intervention and class. These questions also helped provide some insight into students’ reasons for either continuing to take STEM courses or reason for them not to that could be a result from having participated in this course.

**Precalculus concept inventory.** Student achievement scores were obtained from the Precalculus Concept Inventory (Carlson et al., 2010) (see Appendix F). The Precalculus Concept Inventory assessment instrument is a 25-item multiple choice exam that attempts to discern students’ reasoning abilities and conceptual understandings that are central to precalculus and calculus (25 items; $\alpha = 0.73$). These 25 multiple choice questions were divided into three reasoning ability levels: process view of functions, covariational reasoning, and computational abilities (Carlson et al., 2010).

A student who has a process view of function conceives of a function as an entity that accepts a continuum of input values to produce a continuum of output values. A student who engages in covariational reasoning in the context of a function is able to analyze multiple aspects of how the input and output values of a function change together. Computational abilities include facility with manipulations and procedures that are needed when evaluating algebraic representations of functions and solving equations (p. 119).

After looking at these three reasoning functions, the two most appropriate for a college algebra course were reasonings one: process view of function (16 items; $\alpha = 0.62$) and three: computational abilities (9 items; $\alpha = 0.41$); therefore, it was no surprise when looking at which questions were appropriate for this study were the items that came from those two reasoning groups.
These questions were also divided into three “understandings” which articulates the specific function concepts that were needed in order to build and use functions meaningfully. They are: understand meaning of function concepts, understand growth rate of function types, and understand function representations (interpret, use, construct, connect) (p. 120).

The first includes understandings of the meaning and usefulness of function evaluation, rate-of-change, function composition, and function inverse. The second category includes an understanding of the growth patterns of various function types: linear, exponential, rational, and general nonlinear functions. The third category involves understanding the meanings that are conveyed by various function representations (graphical, algebraic, numerical, and contextual) and the connections that exist among these representations (pp. 119-120).

Although the courses taught in this study were not precalculus classes, 12 of the 25 questions were deemed appropriate for the content that students learned in this predominantly college algebra course. These questions were well represented amongst the understanding domains that are appropriate for this course – all but “understand growth rate of function types” subsections three (rational) and four (general non-linear).

Views about mathematics survey. Student’s views on mathematics and self-efficacy were measured using the Views About Mathematics Survey (VAMS) (Carlson, 1997; Carlson et al., 1998) (see Appendix G). The VAMS was created in order to identify the differing views that students held towards the subject of mathematics. These views were classified into profiles based on how students responded to questions on the VAMS. The survey contained 33 statements pertaining to mathematics and aspects of a mathematics course. Each statement was subsequently followed by two contrasting statements in which students had to rate which of these
two statements were truer than the other and to what extent. Figure 3 provides an example of a VAMS item and how it was structured.

Figure 3. Example of a contrasting alternatives item from VAMS.

Once completed in total, of the 33 items, 22 of the statements were used to compute a students’ VAMS profile to determine if they held expert, upper transitional, lower transitional, or naïve views about the teaching, learning, and the practice of doing mathematics (Carlson et al., 1998). Students who were rated to have an expert profile possessed views about mathematics that aligned with how expert mathematicians responded, such as, (they think critically and employ effective problem-solving strategies. Carlson goes on to describe that “[s]tudents with a
folk profile are passive learners and hold naïve views about knowing and learning mathematics. Students with transitional profiles hold a mixture of these views.” (Carlson, 1999, p. 249).

**Youth survey on race and mathematics.** To measure how students viewed their cultural identities in relation to mathematics, I used two subscales of the Youth Survey on Race and Mathematics (YSRM) (English-Clarke, 2011; English-Clarke et al., 2012) (see Appendix H). The YSRM was originally created to investigate the relationship between racial beliefs and mathematical beliefs amongst teenagers in relation to their racial socialization (English-Clarke, 2011). The two subscales used were: (1) *Your Experience with Math* and (2) *Race and Attitudes about Math and Race*. All questions from this survey were five-point Likert scale questions that ranged from *strongly disagree* to *strongly agree*.

The first subscale, *Your Experiences with Math and Race*, consists of seven Likert scale items that asks students to rate their agreement with statements pertaining to students and their interactions with teachers and their peers in relation to race. An example of a question from this subscale includes: “I have been discriminated against by a math teacher because of my race.”

The second subscale was *Attitudes about Math and Race*. This scale originally contained seven statements, but only five were used for this study due to the college context this study is situated in. These statements are concerned with students’ perceptions on stereotypes of how people of their race (Black/African-Americans) experiencing mathematics. Examples of questions from this subscale include “Adults of my race use math in their daily lives” and “Black/African-Americans are held back in math because of their race.”

The other unused scales from the YSRM are concerned with the relationship between students, their parents and families, and mathematics (English-Clarke, 2011). These subscales were not used because they were not appropriate for the context of this study.
**Student mathematics journal reflections.** In order to gauge students’ perceptions of intervention techniques by the experimental group, I required students to turn in a mathematics journal reflection where they responded to several prompts, such as when Leonard and Dantley (2005) and Sheppard (2011) used journal reflections to get periodic updates on their subjects in their research studies. As suggested by Creswell and Plano Clark (2018), these prompts were open-ended and broad in nature in order to ensure students answered in their own words. Students were allowed to elaborate as much (or as little) as they wished to. These were used to track students’ engagement with intended instructional strategies over the course of the intervention. These reflections were used as a way to triangulate what students were stating in the interviews and compare that with a larger sample in the experimental course.

Prompts for these reflections were created using the dimensions from the Culturally Relevant Cognitively Demanding (CRCD) Task Rubric (Matthews et al., 2013). The first reflection was collected at the end of the first intervention lesson as a formative assessment via an online Google Forms survey they completed on computers. The second was collected after students had left class. Students received multiple reminders to complete these reflections and some even completed them before the start of the next class. This method was used due to lack of time at the end of the class block. The subsequent third and fourth intervention classes allotted time at the end of those classes. This was done to maximize the number completed/returned reflection entries. There was a total of four of these completed entries throughout the semester. [See Appendix I for all of the questions that are asked in the reflections]. Table 6 shows the response rate for each journal reflection.
Table 6

<table>
<thead>
<tr>
<th>Journal</th>
<th>Reflection Response Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal</td>
<td>Reflection # 1</td>
</tr>
<tr>
<td>Response Rate</td>
<td>92%</td>
</tr>
</tbody>
</table>

\( n = 25 \)

**Classroom videos.** Video recordings of each of the four-classroom implementation of the intervention were taken in an attempt to gauge how the enacted lesson corresponded to what was planned. These videos also served as a qualitative analysis to see how well the lessons aligned with principles of culturally relevant pedagogy and effective mathematics teaching practices for the experimental section, and just effective mathematics teaching strategies for the control section. Table 7 shows the percentage of adherence and deviations of each intervention lesson in both courses compared to what was intended for that course during the planning of each lesson. This number was calculated by looking at the different components of each lesson, then calculating the amount of time projected that was expected to spend on each one. For each of these time periods, the video recorded lessons were watched and I looked for instances where the enacted lesson veered from what was planned. This could be in the form of skipping a portion of an activity in the interest of time, students taking up more time to discuss with each other or during fruitful whole-group discussions, or students needing more time to work on problems by themselves.

Table 7

<table>
<thead>
<tr>
<th>Lesson Plan Fidelity Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson</td>
</tr>
<tr>
<td>Response Rate</td>
</tr>
</tbody>
</table>

\( (E) – \) Experimental Lesson, \( (C) – \) Control Group Lesson
**Semi-structured interview.** Interviews were a crucial data collection tool in this study to further explore students’ views and perceptions gleaned from the experimental group in the course. This semistructured interview used broad, open-ended questions that allowed for flexibility to let the respondents open up about what they were thinking, yet allow consistency amongst participants (Merriam & Tisdell, 2016). These interviews were broken up into two main sections. The first part contained question related to the course and how students thought and reacted to the content, more specifically, the delivery and interactions with and about the content. These questions were divided into three sections corresponding to the tenets of culturally relevant pedagogy: six questions addressing academic achievement, six questions addressing cultural competence, and four questions surrounding sociopolitical competence. This was intentionally done to align this interview with the theoretical framework.

The second part of the interview was focused towards students’ abilities to think about real-world situations and come up with opinions. The ultimate goal with these situations were to see how students could use mathematics to help them conceptualize the issue and support their argumentation with the mathematics students were describing. Of these three scenarios, two were focused on the sociopolitical construct of culturally relevant pedagogy. These topics were surrounding minimum wage and police shootings and killings of unarmed Black-Americans. The third topic was around planning for social events. This was asked to further investigate students’ mathematical use through a culturally relevant situation. [See Appendix J for the full interview protocol.]

**Procedures**

This quasi-experimental mixed methodological design study was a study in which an experimental group was distinguished from a control group. Participants self-selected which
section of the MATH 1100: College Algebra and Trigonometry I course they would like to be in.
The students did not know which group they had signed up for; although the instructor for the
course pre-determined beforehand the designation of each course through random selection. This
research study had 25 students to agree and fully participate in all aspects of the experimental
group and 24 students to participate in the control section, making for a total of 49 participants.
Students in each class were approached asking them to participate in this study. At the beginning
of the semester, all students (in both groups) were given the four quantitative instruments: (1)
Precalculus Concept inventory (PCI), (2) Views About Mathematics Survey (VAMS), (3) Youth
Survey on Race and Mathematics (YSRM), and (4) Demographic Questionnaire. The PCI was
administered on the first day of the course in the confines of the classroom. The twelve questions
took students approximately 20 minutes to complete. The VAMS, YSRM, and demographics
questionnaire were given after the PCI through a Qualtrics web-based survey. Data was linked
through their names on all instruments and later blinded; however, the data was not to be counted
against participants or viewed until the end of the semester to ensure validity (and reliability) of
the data that was collected. This also helped to make sure students felt safe to express their
unfiltered opinions without fear of retaliation from the instructor.

Following the initial instruments being given to students, the experimental group
experienced a mathematics course that integrated culturally relevant teaching practices
throughout the last month of the semester (see “Intervention” section above). After each
intervention lesson engaged with students, the students in the experimental group completed
their reflections at the end of the class period. Students responded to the given prompts and were
encouraged to fully elaborate on their responses.
Towards the end of the semester, all students (both control group and experimental group) were given the post-PCI test, post-VAMS, and post-YSRM surveys, which were the same as the pre-test and surveys in order to see what, if any, changes happened in students’ mathematical knowledge, abilities, and attitudes towards mathematics. After these final quantitative measures were collected, students from the experimental group were asked to volunteer to take part of a final qualitative data source, a semistructured interview, in which their views of the course, and their views on mathematics were explored further. These students were selected based off this convince sample, but final student selection was solicited from students who attended all experimental lessons. This was done in an attempt to document and triangulate changes seen by students from the pre- to post-PCI test, pre- to post-VAMS survey, pre- to post-YSRM survey, interviews, and reflections. A total of eight students agreed to participate in the interviews.

Data Analysis

In order to adhere to an embedded mixed methods design, the data analysis phase began after the conclusion of all quantitative and qualitative data collection. The quantitative data was analyzed first, followed by the qualitative data. After all the data was analyzed individually, the quantitative and qualitative data was integrated and the findings and other relevant conclusions will be presented in subsequent chapters of this dissertation.

Precalculus Concept Inventory and Course Assessments

Data analysis began once the courses came to an end because the three quantitative instruments were re-administered at the end of the course, and the qualitative instruments also occurred at the conclusion of the course. I began by evaluating the responses students gave on the Precalculus Concept Inventory. I graded each multiple-choice assessment response as either
correct or incorrect. After grading, I assigned an overall score to use when running statistical analyses as the sum of the correct responses. Students’ grades from each of five course assessments and their final grades were also used in quantitative data analysis, as well. This information was extracted and downloaded from the Pearson MyMathLab website and inserted into Microsoft Excel.

**Surveys**

After the mathematics assessments had been graded and analyzed, the pre- and post-surveys (Demographics Questionnaire, Views About Mathematics Survey, and the Youth Survey on Race and Mathematics) were collected and cleaned based on incomplete data values. Students who completed only one of the surveys had their responses removed from either the pre- or post-survey they did complete. This was done in order to run paired hypothesis statistics tests so that students could be matched/paired with themselves. After the data was cleaned and the data set was complete, I began to analyze the data using the Stata data analysis program. I ran descriptive statistics (means, median, standard deviations, etc.) in order to get a holistic view of the groups, after which, I performed comparisons of the means tests, such as paired t-tests and analysis of variance (ANOVA) in order to test for difference between the variables, pre- and post-test, and difference between group means after any other variance in the outcome variables were accounted for. Cohen’s d was also calculated to see what, if any, effect the intervention had on students’ ability to improve their scores on the mathematics assessment. Next, I calculated more inferential statistics, such as correlations and some regression analysis to address the research questions.
Interview and Reflection Journals

After the quantitative analyses were conducted, the qualitative data analysis began. As Merriam and Tisdell (2016) suggest, I immediately wrote reflections following each of the interviews with the eight participants. These reflections contained some important insights that were suggested by the interview participants, including thoughts on behavior, non-verbal cues, and other thoughts and/or reactions (p. 131), which were consulted during the data interpretation process. Voice recordings of the interviews were transcribed following guidelines from Ochs (1979): a word-for-word with indications of any elongated pauses or brakes in communication documented, along with turns, marked by changes with the speaker at each timestamp. Transcripts utilized modified orthography (e.g., wanna, gonna, cus) to stay close to the actual utterances of the students. Transcripts were shared with participants to make sure that what was recorded aligned with what the participants tried to portray.

Analysis of the interviews took place using ATLAS.ti 8, printed transcripts, and Microsoft Excel. This aided in identifying relevant sections of the interviews that were important to the researcher. Transcripts were also printed in order to physically interact (through highlighting and writing notes) with the data. Different coding procedures were used for the each of the two parts of the interview: Part One: The Class and Part Two: The Issue and Mathematics. For part one, the first iteration of coding began through theory driven coding as outlined by DeCuir-Gunby, Marshall, & McCulloch (2011). Theory-driven codes were a priori codes generated from the literature that directly relates to culturally relevant pedagogy (academic achievement, cultural competence, and sociopolitical consciousness) (see Table 8). Once these were identified, the next coding pass revisited and revised these blocks in order to place them
within the context of this study. This was done in order to make sure the codes were “conceptually meaningful, clear and concise, and close to the data” (p. 143).

Table 8

<table>
<thead>
<tr>
<th>Theory-Driven Code</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language empowerment</td>
<td>A statement made about spoken languages or dialects.</td>
<td>N/A*</td>
</tr>
<tr>
<td>Leveraging culture and community</td>
<td>A statement about culture with specific references to the community.</td>
<td>N/A*</td>
</tr>
<tr>
<td>Preservice teachers engaging with students’ culture</td>
<td>A statement about preservice teachers and how they allowed students to use their cultures.</td>
<td>N/A*</td>
</tr>
<tr>
<td>Connect math to real-world</td>
<td>A statement that shows students making connections with their culture and the real-world.</td>
<td><em>They were all very good topics [the lessons done in class], being a freshman coming into college; but I think my most favorite one will be the STD one because it was taught right around homecoming and everybody was just wow. In class it had everybody shook because, I mean, it spoke facts. And it was around this time where us coming in to college we really didn’t get to talk about protection and stuff. But we did go in depth on how many kids actually get sexually transmitted diseases as freshmen or in college general so that was a good one. (Ahshante)</em></td>
</tr>
</tbody>
</table>

*Note. Not all a priori codes showed up in analysis

Once these code groups were generated, these statements were coded through the use of open coding in order to conceptualize what was said by respondents (Strauss & Corbin, 1990). After open coding, axial coding was conducted in order to collapse codes into larger categories
through constantly comparing codes with each other and developing categories from pools of concepts discovered in the data. Not all the text was captured using these theories driven codes, so data driven coding took place to uncover the remaining themes from the interview data (see Table 9). Using the same coding scheme of open and axial coding, themes also arose from the remaining data. Throughout this process, constant memoing took place to capture the researcher’s thoughts during this process (Charmaz, 2006). These documents will be aligned with the participant interviews.

Table 9

<table>
<thead>
<tr>
<th>Data Driven Code</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>HBCU</td>
<td>A statement about why students chose to attend an HBCU.</td>
<td>I went to a private elementary school until fifth grade I went to a predominantly White school from six to twelfth grade, so I was surrounded by White people my entire life and then my friend, my best friend, was like: “you’re White in your soul” and then it’s like, she got to know me more and then it’s like, “okay there’s your Black side.” That kinda stuck with me. I knew I wanted to be around people who looked like me, and I figured there wasn’t a better place to do that than an HBCU. (Pamela)</td>
</tr>
</tbody>
</table>

| Culture definition | A statement defining what “culture” is. | Well [culture] all about how we you know as African-American people act towards each other, like how we carry ourselves with so much pride. Even though we may not show it whenever someone has like has been killed – like a Black person is always being killed. I think the pride shows up when you see how many people will stand. (Jamie) |

The second part of the interview was coded solely using the data driven coding methods as described before, since there was no theory to guide this data analysis.
The mathematics reflection journals were used as a way to triangulate the qualitative data. They were used to corroborate the responses made by the interview participants with how others in the course thought about the lessons (DeCuir-Gunby et al., 2011; Strauss & Corbin, 1990).

**CRCD Analysis Tool**

The framework that informed the data collection and analysis of the lesson plans and videotaped classroom sessions was Matthews, Jones, and Parker’s (2013) Culturally Relevant Cognitive Demand (CRCD) Mathematics Task Framework (Figure 4) and its corresponding evaluation tool (see Appendix D). I used this tool to analyze lesson plans and classroom videos of the lessons that were designed to have an emphasis on culturally relevant pedagogy. This also aided in the analyzing of interviews that were conducted. This framework is derived from two different bodies of research: (i) Effective mathematical teaching practices through using higher level, cognitive demanding mathematical tasks (Smith & Stein, 1998; Stein, Smith, Henningsen, & Silver, 2009) and (ii) culturally relevant pedagogy (see Chapter 2: Literature Review).

**Effective mathematics teaching practices.** Smith and colleagues distinguish between lower-level cognitive demanding tasks as those that classified as memorization and procedures without connections to understanding, meaning, and concepts. High-level cognitive demanding tasks are those classified as procedures with connections to understanding, meaning, and concepts and doing mathematics. Something distinguishing between the lower-level and the higher-level tasks is the lack of opportunity in the lower-levels to connect the mathematics with students’ communities. The higher-level tasks will require students to connect those memorized concepts, procedures, and algorithms to important mathematical ideas (procedures with connections) while doing mathematics is often nonalgorithmic and requires students to engage in
an open-ended word problem with many avenues to solving and requires much greater thought and explanation (Jones, 2015; Matthews et al., 2013).

Connecting the higher-level tasks with the goals of culturally relevant pedagogy requires a cultural amendment to Stein et al.’s (2000) descriptions of the two categories. The two higher-level tasks should be described as: “a) procedures with connections to concepts, meaning and understanding of mathematics, culture, and community, and b) doing mathematics for the purpose of becoming empowered intellectually, culturally, politically and socially” (Matthews et al., 2013, p. 132).
There are a total of eight dimensions of this framework. It is divided into eight areas of focus that have to be labeled as high, moderate, or low with regards to the degree that description is seen in the structure of the task. From the framework, we can see that those areas are:
1. Mathematics task explicitly requires students to inquire (at time problematically) about themselves, their communities, and the world about them.

2. May draw from connections to other subjects and issues.

3. Mathematics task draws from students’ community and cultural knowledge.

4. Task may explicitly seek to add to this knowledge through mathematical activity.

5. (a) Task is mathematically rich and cognitively demanding, 
   
   (b) embedded in cultural activity.

6. Task asks students to engage the discontinuity and divide between school and their own lives – home and school.

7. Task is real-world focused, requiring students to make sense of the world through mathematics.

8. The explicit goal of the task is to critique society – that is, make empowered decisions about themselves, communities, and world.

**Experimental group’s “intervention” lessons.** In the experimental group, lesson plans were analyzed before each implementation using three peer-reviewers who are highly knowledgeable about culturally relevant pedagogy and who were trained on how to use the CRCD task framework. Each lesson was created by the researcher and then rated individually by the researcher and the three reviewers for alignment with culturally relevant pedagogy and effective mathematics teaching practices with the CRCD task framework. In order to be considered a culturally relevant pedagogical lessons, each lesson should rank high on each of the eight dimensions of the framework. Once ratings were completed, a discussion was held to discuss inconsistencies. After the discussions, comments and suggestions were given on how to
make the lessons rank higher on the scales. With this feedback, the researcher reconstructed lessons and the team rated the lessons again, then implemented in the experimental group.

**Control group’s lessons.** The control group also received lessons on the same day as the experimental group that were also analyzed using this tool; however, those lessons ranked low on the portions of the task rubric that were pertaining to culturally relevant pedagogy practices (dimensions 1, 3, 5b, 6, and 8). These lessons were designed with effective mathematics teaching practices, so they ranked high on those dimension (2, 4, 5a, and 7). These lessons were created, analyzed, altered, reanalyzed, and implemented in the same ways as the experimental group’s lessons were.

**Classroom videos.** The classroom videos were viewed and analyzed for their alignment with the CRCD task rubric. These were used to see if what was intended in the lesson plan actually transpired during the enacting phase (see Table 7). This table shows that the experimental group in some instances took longer on class discussions, due to the direction that the students led. The content, as you will see in the results chapters, got students involved and thus, culturally relevance was permeating the courses. In the control class, fidelity with the intended lessons were nearly perfect in each course. Students were focused on completed their tasks with no explicit discussions referencing the culture of the students in the class.

**Data Analysis and Research Questions**

**Research question one.** What effect does culturally relevant pedagogy have on student achievement in a college algebra course offered at a historically Black university? This research question was analyzed with quantitative measures, including course assessments (five-unit tests and final grades) and the Precalculus Concept Inventory. Students in both the control group and the experimental group completed the Precalculus Concept Inventory assessment at the
beginning of the semester and also at the end of the semester. Students had their scores graded and analyzed by using descriptive statistics and inferential statistics (paired t-tests, two-sample t-tests, and Cohen’s $d$) in order to see how each class performed compared to one another and personal growth from the beginning of the course to the end of the course.

**Research question two.** *How are student views about mathematics affected in a course centered around culturally relevant pedagogy?* This question was answered using quantitative and qualitative data. The quantitative data was gathered from the Views About Mathematics Survey. Qualitative data was from the student interviews, where students will have the opportunity to elaborate on how they see themselves in regards to their ability to do mathematics.

For the quantitative data, I conducted analyses including descriptive statistics, graphs, and regression using the Views About Mathematics Survey and the demographics questionnaire. I also conducted a correlation analysis to investigate any possible relationships amongst all quantitative measures. For the qualitative aspect of this question, I used information gathered from the student interviews (and verified with the math journal reflections) to elaborate on what students thought about mathematics, in general, and the relationship between culturally relevant pedagogy and this course.

I also used the mathematics journal reflections to verify information from the interviews to get students’ perceptions through this form of immediate feedback after every “intervention” lesson that uses this form of culturally relevant pedagogy. Through the student interviews, I hoped to gather a more in-depth analysis of students’ thoughts and feelings that they may not have expressed via the online reflections. During this interview, students had time to process the entire course and to really look back on what they learned and, importantly for me, how they were able to learn, and through what modes.
Research question three. How do students enrolled in a college algebra course at a historically Black university define and describe their culture and their experiences with lessons designed to be culturally relevant? This question was also answered using quantitative and qualitative data. The quantitative data was gathered from the Youth Survey on Race and Mathematics. Qualitative data was from the student interviews.

For the quantitative data, I conducted descriptive, correlation, crosstabulations, and tests for independence analyses using the Youth Survey on Race and Mathematics in combination with the Demographics Questionnaire. For the qualitative features of this question, I used information from the student interviews in order to elaborate on what students thought about mathematics, in general, and the relationship between race, mathematics, and this course.

Research question four. How are students able to critique discourses of power using mathematics as a tool? Only qualitative data was collected. Qualitative data came from the student interviews, specifically the second half of the interview. During this portion of the interview, students were presented with three sociopolitical or culturally relevant scenarios and asked their opinions and express how student could use mathematics to help conceptualize the problem and give possible solutions to it.

Table 10 shows a summary of the research questions juxtaposed against the data collections and data analysis plan.
Table 10

Mapping of Research Questions to Data Sources and Analysis Methods

<table>
<thead>
<tr>
<th>CRP Tenet</th>
<th>Research Questions</th>
<th>Quantitative Data Sources and Analysis</th>
<th>Qualitative Data Sources and Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>1. What effect does culturally relevant pedagogy have on student achievement in a college algebra course offered at a historically Black university?</td>
<td>• Precalculus Concept Inventory (PCI)</td>
<td>• Math Journal Reflections</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Student Test Grades</td>
<td>o Initial Coding using CRCD Tool</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Descriptive Statistics</td>
<td>o Additional Emerging Codes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Graphs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Paired t-tests</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Two-Sample t-tests</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>o Cohen’s $d$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. How are student views about mathematics affected in a course centered around culturally relevant pedagogy?</td>
<td>• Views of Mathematics Survey (VAMS)</td>
<td>• Student Interviews</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Descriptive Statistics</td>
<td>o Initial Coding using CRCD Tool</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Graphs</td>
<td>o Additional Emerging Codes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Correlation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Regression</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. How do students enrolled in a college algebra course at a historically Black university define and describe their culture and their experiences with lessons designed to be culturally relevant?</td>
<td>• Youth Survey on Race and Mathematics (YSRM) subsections 2 (Your experiences with math and race) and 4 (Attitudes about math and race)</td>
<td>• Math Journal Reflections</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Descriptive Statistics</td>
<td>o Initial Coding using CRCD Tool</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Graphs</td>
<td>o Additional Emerging Codes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Correlation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Crosstabulations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Fisher’s Exact Test for Independence</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. How are college algebra students able to critique discourses of power using mathematics as a tool?</td>
<td>• Student Interviews</td>
<td>• Student Interviews</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Initial Coding using CRCD Tool</td>
<td>o Initial Coding using CRCD Tool</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Additional Emerging Codes</td>
<td>o Additional Emerging Codes</td>
</tr>
</tbody>
</table>
Data Integration

The quantitative data and qualitative data were initially analyzed separately. After that initial analysis was completed, the integration and interpretation (Creswell & Plano Clark, 2018) process began. Integrating the data allowed the quantitative data to be enhanced through the qualitative interpretations. The experiences of participants in the intervention group are understood by subjective experiences. This integration also provided insights into outcomes that were valued, not only by the researcher, but also by the participants themselves. The combination of quantitative and qualitative data provided useful insights into any change in scores experience by the groups from pre- to post-assessments.

Validity and Reliability

In order to help address validity and reliability concerns, appropriate steps were conducted in order to promote strong research. Multiple forms of data were collected throughout the duration of the study in order to triangulate the subsequent results from the study.

Lessons and the course. In alignment with the theoretical framework, culturally relevant pedagogy, the lessons were created and using the Culturally Relevant Cognitively Demanding (Matthews et al., 2013) task framework. Lessons were rated in conjunction with this tool by the researcher and colleagues who are highly familiar with diversity and equity issues in mathematics in broad, and culturally relevant pedagogy, specifically. Each lesson was initially created by the researcher, rated by the researcher, then rated by colleagues. Once a lesson was rated using the various dimension of CRCD framework as low, medium, or high, the researcher and colleagues discussed how the lessons could be improved. Once changed, the team came to a consensus and the lessons were finalized and implemented.
A tabulation of the level of fidelity with implementation of these lessons compared to how they were created can be found in Table 7. Fidelity of the instructional materials are paramount to the claims that can potentially be made about this study. The goal is to compare good mathematics teaching practices to what I feel is even better mathematics teaching practices through culturally relevant pedagogy. To help in the validation of this course, I provide evidence from the course evaluations students completed towards the end of the course, in which the instructor had not access to the information until several weeks after the end of the posting of grades (to ensure no retaliatory actions are not taken against students). A few key questions on this survey emerged that speaks to students’ perceptions of this course and the instructor’s teaching methods. Question 10: The instructor uses instructional approaches (for example, discussions, lectures, audio-visuals, field work saw agreement from 90% (80% strongly agree) from the experimental group and 100% agreement (with 64.7% strongly agreeing) in the control course. Question 15: This instructor is effective in promoting learning; saw 95% in agreement (75% strongly agree) in the experimental group and 100% agreement (76.5% strongly agree) in the control group. These two questions help verify that from the perception of the two different classes, students thought they were receiving adequate or good mathematics teaching from a competent instructor.

**Quantitative instruments.** For the quantitative measures, the Precalculus Concept Inventory, the Views of Mathematics Survey, and Youth Survey on Race and Mathematics questions were not changed too much from how they were implemented in previous research, thus similar results should arise. These measurements were all validated instruments which reported their validity and consistency.
**Qualitative instruments.** For the qualitative data, the reflections and interviews, credibility measures were also in place. Both the reflections and the interviews were coded using multiple iterations to make all significant information was extracted from the data. Peer reviews by fellow colleagues astute in culturally relevant pedagogy and trained by the researcher, served as a method to ensure codes were accurate and reliable. The codebook was updated to make sure all codes were accurately describing the text. Member checks were conducted with participants for the student interviews to make sure what was recorded and transcribed aligns with what the participants tried to portray. Thick, rich descriptions were utilized so that readers of this research would be able to get a clear and deep understanding of participants’ responses. Instead of the researcher having to be the medium of data transfer to the audience, the participants will be able to speak for themselves.

**Positionality Statement**

As a former teacher with three years of high school mathematics experience at a large public, urban school, I understand and am aware of the roles and responsibilities that surround being a teacher of mathematics to a large-diverse population of students. I currently teach at the large, public historically Black college/university in the southeastern part of the United States in which this study is situated. I am also an African-American/person of color who taught primarily people who looked like I do.

After reflecting on my teaching practices at the high school level, I did teach using some culturally relevant teaching practices; however, most of them revolved around the first two tenets of culturally relevant pedagogy (academic achievement and cultural competence) and not so much in building my students’ sociopolitical consciousness. My teaching was built around getting to know the students as people first and to let them in on certain aspects of my life.
During my year of student teaching, I realized that these personal connections are vital and necessary, but not sufficient. I tried connecting the material to their lives to peak their interest, which worked somewhat, but where I found my success is when I got the students to trust me: that I had their best interests at heart and I would listen to them when they spoke not only about the content of the class, but also the content of their lives.

I am cognizant that I lack any understanding of the experience of what it is like having more than five years of mathematics secondary and tertiary teaching experience or what it is like to be a teacher in the majority race faced with teaching students of color who look nothing like me. I seek to gain empirical evidence from working with students of color in mathematics teaching with culturally relevant pedagogy, all three tenets, in mind. I have read many articles relating to culturally relevant teaching practices and have read the countless benefits of each case that was written about. That being said, this could seemingly cause me to have some blind spots when it comes to implementing and conducting an unbiased research study. I plan to mitigate my possible perceived preconceptions and biases by being aware of them and not letting them get in the way of solid mixed methodological research.

**Comments on Culturally Relevant Pedagogy and its Prevalence in the Control Course.**

As researcher and instructor, I acknowledge that the validity of this study hinges on the premise that the experimental section was based on culturally relevant pedagogy and the control section was not. Through the intervention, each section had lessons that were designed to be both mathematically effective, but the control course lacked cultural relevance in these lessons. As a reader, you may wonder how I can be sure that the control group did not have influence by culturally relevant pedagogy due to the fact that the students and the instructor share the same race.
It is my position that just because the instructor and students share a similar trait, does not automatically mean that culturally relevant pedagogy exists. Yes, that indeed would make it easier to have some naturally occurring cultural experiences during a course that is based on culturally relevant pedagogy; however, to claim a course is culturally relevant pedagogy, it should not and cannot be held only through phenotypical traits. It must be intentionally interwoven and permeated throughout the mathematical content of the lessons, themselves, which must be designed with students’ interests and their cultures in mind. It is my position that the experimental course achieved this permeation throughout the second half of their course, while the control group did not have such experience. This is the comparison that the research results will explore throughout the next three chapters.
CHAPTER 4: QUANTITATIVE RESULTS

In this chapter, I will discuss the analysis of the quantitative data and findings that relate to the first three research questions. Within this embedded quasi-experimental mixed methods design, four different instruments were administered at the beginning of the course/prior to the intervention and again at the end of the course to students enrolled in the experimental and control classes. These instruments included a demographics questionnaire, a subset of questions from the Precalculus Concept Inventory (Carlson et al., 2010), the Views About Mathematics Survey (Carlson et al., 1998), and two subscales from the Youth Survey on Race and Mathematics (English-Clarke, 2011). Students’ performance on unit tests before and after the intervention, final exam scores, and course grades were also examined.

Quantitative Analyses for Research Question One

The quantitative data presented in this section will address the following research question: What effect does culturally relevant pedagogy have on student achievement in a college algebra course offered at a historically Black university? This section will begin with a presentation of results from the unit tests students took before and after the intervention, students’ grades on the final exam, and overall course grades.

Course Assessment Performance Within Each Section

Analyses were performed on five common unit tests, the course final exam, and students’ overall final grades in the experimental and control groups. Each unit assessment contained 20 free-response items in which students completed online, via Pearson’s MyMathLab software. Each one was graded by the online program, allowing for partial credit on items that contained multiple parts. This grading scheme reduced any potential biases from the researcher, for it
allowed the data to be graded consistently and remain uninfluenced by the researcher in either course.

The interventions delivered to the experimental group began during the middle of semester, after the seventh week of a 14-week course. During the time before the intervention began, students took and received grades on two-unit tests. Once the experiment began, students took and received grades on three additional unit tests and a final exam (see Figure 5 for distributions).

Figure 5. Student summative test averages by section.

Summary statistics (mean, standard deviation, minimum, median, maximum, skewness, and kurtosis) of students’ performance on these six assessments along with their overall course grades are shown in Table 11. Test for normality were included to ensure parametric tests were correct for this sample, because the sample size is less than 30. Skewness and kurtosis levels for these results were within appropriate parameters for parametric tests to be conducted (Ghasemi
& Zahediasl, 2012). The average unit test scores before the intervention for the experimental groups was 51.89 with a standard deviation of 24.64, whereas the control group was a 57.2 and a standard deviation of 24.72. The average scores after the intervention was 76.49 with a standard deviation of 14.98 for the experimental group, where the control group’s post-intervention unit test average score was 60.66 with a standard deviation of 33.55.
**Table 11**

*Student Summative Test and Final Grades by Section*

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Min</th>
<th>Med</th>
<th>Max</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Pre-Intervention)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 1 Test</td>
<td>44.88</td>
<td>32.88</td>
<td>0</td>
<td>40.63</td>
<td>90.63</td>
<td>-0.2008</td>
<td>1.52</td>
</tr>
<tr>
<td>Unit 2 Test</td>
<td>55.68</td>
<td>33.91</td>
<td>0</td>
<td>75</td>
<td>100</td>
<td>-0.5826</td>
<td>1.94</td>
</tr>
<tr>
<td>Pre-Intervention Test Avg</td>
<td><strong>51.89</strong></td>
<td><strong>24.64</strong></td>
<td>0</td>
<td><strong>43.53</strong></td>
<td><strong>88.17</strong></td>
<td><strong>-0.097</strong></td>
<td><strong>2.08</strong></td>
</tr>
<tr>
<td>(Post-Intervention)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 3 Test</td>
<td>70.22</td>
<td>23.91</td>
<td>5.21</td>
<td>78.65</td>
<td>100</td>
<td>-1.08</td>
<td>3.57</td>
</tr>
<tr>
<td>Unit 4 Test</td>
<td>78.54</td>
<td>22.26</td>
<td>0.00</td>
<td>86.41</td>
<td>100</td>
<td>2.01</td>
<td>7.28</td>
</tr>
<tr>
<td>Unit 5 Test</td>
<td>80.73</td>
<td>17.16</td>
<td>26.67</td>
<td>82.50</td>
<td>100</td>
<td>-1.67</td>
<td>5.96</td>
</tr>
<tr>
<td>Post-Intervention Test Avg</td>
<td><strong>76.5</strong></td>
<td><strong>14.98</strong></td>
<td><strong>43.96</strong></td>
<td><strong>82.49</strong></td>
<td><strong>95.83</strong></td>
<td><strong>-0.675</strong></td>
<td><strong>2.3</strong></td>
</tr>
<tr>
<td>Final Exam</td>
<td>74.13</td>
<td>20.43</td>
<td>22.20</td>
<td>80.15</td>
<td>98.69</td>
<td>-1.28</td>
<td>3.92</td>
</tr>
<tr>
<td>Final Course Grade</td>
<td><strong>82.49</strong></td>
<td><strong>13.18</strong></td>
<td><strong>55.00</strong></td>
<td><strong>86.13</strong></td>
<td><strong>98</strong></td>
<td><strong>-0.895</strong></td>
<td><strong>2.53</strong></td>
</tr>
<tr>
<td>Control Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Pre-Intervention)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 1 Test</td>
<td>57.69</td>
<td>28.96</td>
<td>0</td>
<td>65.63</td>
<td>100</td>
<td>-0.2888</td>
<td>1.932</td>
</tr>
<tr>
<td>Unit 2 Test</td>
<td>56.71</td>
<td>31.41</td>
<td>0</td>
<td>64.29</td>
<td>100</td>
<td>-0.7127</td>
<td>2.395</td>
</tr>
<tr>
<td>Pre-Intervention Test Avg</td>
<td><strong>57.2</strong></td>
<td><strong>24.72</strong></td>
<td>0</td>
<td><strong>57.82</strong></td>
<td><strong>98.44</strong></td>
<td><strong>-0.624</strong></td>
<td><strong>2.942</strong></td>
</tr>
<tr>
<td>(Post-Intervention)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 3 Test</td>
<td>61.29</td>
<td>30.91</td>
<td>0</td>
<td>71.35</td>
<td>100</td>
<td>-0.6122</td>
<td>2.0957</td>
</tr>
<tr>
<td>Unit 4 Test</td>
<td>62.57</td>
<td>43.35</td>
<td>0</td>
<td>82.5</td>
<td>100</td>
<td>-0.728</td>
<td>1.6486</td>
</tr>
<tr>
<td>Unit 5 Test</td>
<td>58.13</td>
<td>40.71</td>
<td>0</td>
<td>78.13</td>
<td>100</td>
<td>-0.6667</td>
<td>1.6315</td>
</tr>
<tr>
<td>Post-Intervention Test Avg</td>
<td><strong>60.66</strong></td>
<td><strong>33.55</strong></td>
<td>0</td>
<td><strong>75.45</strong></td>
<td><strong>97.57</strong></td>
<td><strong>-0.6628</strong></td>
<td><strong>1.996</strong></td>
</tr>
<tr>
<td>Final Exam</td>
<td>62.5</td>
<td>21.05</td>
<td>8.75</td>
<td>65.39</td>
<td>97.07</td>
<td>-0.8069</td>
<td>3.119</td>
</tr>
<tr>
<td>Final Course Grade</td>
<td><strong>70.02</strong></td>
<td><strong>22.5</strong></td>
<td><strong>19.47</strong></td>
<td><strong>82.6</strong></td>
<td><strong>93.74</strong></td>
<td><strong>-0.8355</strong></td>
<td><strong>2.3839</strong></td>
</tr>
</tbody>
</table>
From this table, it is evident that for the experimental group, test scores from before the intervention to after the intervention increased nearly 25 percentage points, while scores increased in the control group by 3.5 percentage points. To confirm the importance of these numbers, paired t-tests were run on the pre-intervention unit test averages (units one and two) with the post-test averages (units three, four, and five) to see if students within each group significantly improved from the beginning of the course to the end of the course. It was hypothesized that the mean difference for the experimental group (post-pre) would be greater than zero, meaning students would score significantly higher on the post-unit tests that then pre-unit tests. For the control group, it was hypothesized that the difference (post-pre) would equal zero. Results from these analyses are shown in Table 12.

From the table we can see that the experimental group was shown to have a statistically significant change from pre-unit assessments to post-unit assessments (at the $p < .0001$ level), while the control group was not shown to have any statistically significant changes from pre-unit tests to post-unit tests ($p = 0.5451$). These results suggest that for the experimental group, the intervention produced significant changes in the grades of the students within their class over the duration of the course, while the control group, which received no such intervention, did not show a statistically significant increase from the first two unit tests compared to the last three unit tests.
Table 12

*Paired Unit Test Averages for Course Sections*

<table>
<thead>
<tr>
<th>Course Section</th>
<th>Experimental</th>
<th>Control</th>
<th>( t )</th>
<th>( df )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Test Pre-Intervention Average</td>
<td>51.89 (24.64)</td>
<td>57.2 (24.59)</td>
<td>5.45***</td>
<td>24</td>
</tr>
<tr>
<td>Unit Test Post-Intervention Test Average</td>
<td>76.5 (3.00)</td>
<td>60.66 (6.23)</td>
<td>0.613</td>
<td>28</td>
</tr>
<tr>
<td>Difference (Post – Pre)</td>
<td>24.61 (22.56)</td>
<td>3.46 (30.45)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *** = \( p \leq .0001 \). Standard Deviations appear in parenthesis below means.

Comparison Between Sections of Students’ Performance on Unit Assessments

The next set of analyses conducted was to gauge how students in the experimental course fared against the control group (across group analysis). Table 13 shows the results from t-test comparisons from the experimental course against the control group for the pre-unit test average (to see if the groups differed significantly at the beginning of the course), post-unit test average (to see if the groups differed significantly after the introduction of the intervention), the final exam grade and the overall course grades (to see if the intervention had an overall effect on material learned throughout the course).

Table 13

*Pre-Unit Test Averages*

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>( t )</th>
<th>( df )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (A)</td>
<td>51.89</td>
<td>24.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Group (B)</td>
<td>57.2</td>
<td>24.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference (A-B)</td>
<td>-5.31</td>
<td>24.72</td>
<td>-0.788</td>
<td>52</td>
</tr>
</tbody>
</table>

From the analysis, the average for the experimental group was 51.89 with a standard deviation of 4.93 and the average for the control group was 57.74 with a standard deviation of 4.59. A two-sample t-test was conducted using students’ scores on the first two unit assessments to determine if students’ performance in the course significantly differed from each other at the
beginning of the intervention. The results of the two-sample t-test showed that there was no significant difference between the two groups at the before start of the intervention ($p = .4343$). In other words, the students in both groups performed at the same level, given the instructional methods prior to the intervention.

With respect to the unit test averages after the intervention, it was hypothesized was that students in the experimental course would perform better than students in the control group due to the (culturally relevant pedagogy) intervention and that the difference between the experimental group and control groups should result in a positive difference (experimental – control). A two-sample t-test was conducted using students’ scores on the three post-unit assessments to determine if students’ performance in the course significantly differed from each other after the intervention (Table 14). The results of the two-sample t-test showed that there was a significant difference between the two groups ($p = .017$). This statistic shows that the experimental group outperformed the control group with the only change in the classes was the introduction of the intervention lessons.

Table 14

<table>
<thead>
<tr>
<th>Post-Unit Test Averages</th>
<th>M</th>
<th>SD</th>
<th>$t$</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (A)</td>
<td>76.5</td>
<td>3.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Group (B)</td>
<td>60.66</td>
<td>6.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference (A-B)</td>
<td>15.84</td>
<td>7.27</td>
<td>2.178**</td>
<td>53</td>
</tr>
</tbody>
</table>

Note. **= $p \leq .02$.

Similarly, to the post-unit test averages, the experimental groups also outperformed students in the control group with regards to the final exam grades and overall final grades in the course. For the final exam scores, the experimental group achieved a collective average of 74.13, while the control group had an average of 62.5. A two-sample t-test was conducted using students’ scores on the final exam scores to determine if students’ performance in the course
significantly differed from each other after the intervention. The results of the two-sample t-test showed that there was a significant difference between the two groups ($p = .0226$). For overall scores in the course (homework, quizzes, tests, and final exam), students in the experimental group achieved a collective average of 82.74 (standard deviation equal to 2.76) and the control group had an average of 70.03 (standard deviation equal to 4.18). A two-sample t-test was also conducted using students’ scores on these final course grades to determine if students’ performance in the course significantly differed from each other after the intervention. The results of the two-sample t-test showed that there was a significant difference between the two groups ($p = .0098$). These results also help show that the intervention had overarching effects throughout the course.

**Effect Sizes of Intervention on Assessments**

To examine the effect size Cohen’s $d$ statistical measure was used. To evaluate the strength of relationships, Cohen’s standard was used (Cohen, 1988), where coefficients between .20 and .49 represent a small effect size, coefficients between .50 and .79 represent a moderate effect size, and coefficients above .80 represent a large effect size. There was a significant effect size on the post-intervention unit test scores of 0.59. This indicates that the intervention had a medium effect on the outcome of the unit test averages. Similarly, effect size for the final exam, and final grades were also calculated. The intervention had a Cohen’s $d$ effect size of 0.56 for the final exam and the overall course grades experienced a Cohen’s $d$ effect size of 0.66. These values indicate that the intervention had a medium to large effect on the outcomes of the unit test grades, final exam grades, and overall course grades.
Precalculus Concept Inventory Performance within Each Section

Also included in analysis for research question one was students’ performance on a subset of questions from the Precalculus Concept Inventory (PCI) that were deemed relevant to the concepts that were taught and learned in this course, projecting students’ readiness to take precalculus then calculus (Carlson, Oehrtman, & Engelke, 2010). Table 15 provides a summary. The numbers reported here are the number of questions students answered correctly out of the 12 questions on the assessment (with no partial credit given on each response). The average PCI score at the beginning of the course for the experimental group was 1.7308, standard deviation of 1.2184, compared the control group which had an average of 2, standard deviation of 1.6475. Post-intervention results for the experimental groups yielded nearly a four question increase per student (average = 5.3462, standard deviation = 2.2793) while the control group increased saw a near two question increase in their collective responses (average = 3.7931, standard deviation = 2.1444). The skewness and kurtosis levels for these results are within appropriate parameters for normality assumptions, where skewness is close to zero and kurtosis is close to three (Ghasemi & Zahediasl, 2012).

Table 15

Precalculus Concept Inventory Achievement by Section

<table>
<thead>
<tr>
<th>Section</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Med</th>
<th>Max</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Pre-Intervention)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental Group</td>
<td>1.731</td>
<td>1.218</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>0.394</td>
<td>3.276</td>
</tr>
<tr>
<td>Control Group</td>
<td>2.000</td>
<td>1.648</td>
<td>0</td>
<td>2</td>
<td>7</td>
<td>1.073</td>
<td>4.238</td>
</tr>
<tr>
<td>(Post-Intervention)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental Group</td>
<td>5.346</td>
<td>2.279</td>
<td>1</td>
<td>5.5</td>
<td>10</td>
<td>0.1</td>
<td>2.255</td>
</tr>
<tr>
<td>Control Group</td>
<td>3.793</td>
<td>2.144</td>
<td>0</td>
<td>4</td>
<td>7</td>
<td>-0.125</td>
<td>2.052</td>
</tr>
</tbody>
</table>

Paired t-tests were conducted using change in students’ pre/post scores on the PCI to determine if the change in students’ performance on items measuring their knowledge of
students’ readiness to take precalculus from the algebraic concepts studied in the course significantly differed from the beginning to the end of this course. The results of the paired t-tests are shown in Table 16. Results from this analysis showed that students in both sections significantly performed better on the post-PCI than they did at the beginning of the course (both groups \( p < 0.0001 \)). These results show that students learned throughout the semester regardless of primary instructional styles, be it culturally relevant pedagogy, or with good mathematical teaching practices void of culturally relevant pedagogy. The question now is whether the culturally relevant pedagogical approach showed a significantly higher performance than did the non-culturally relevant lessons did.

Table 16

<table>
<thead>
<tr>
<th>Course Section</th>
<th>Experimental</th>
<th>Control</th>
<th>( t )</th>
<th>( df )</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI Pre-Intervention Average</td>
<td>1.731</td>
<td>2.000</td>
<td>6.756***</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>(1.218)</td>
<td>(1.648)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCI Post-Intervention Test Average</td>
<td>5.346</td>
<td>3.793</td>
<td>5.090***</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>(2.279)</td>
<td>(2.144)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference (Post – Pre)</td>
<td>3.615</td>
<td>1.793</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.729)</td>
<td>(1.897)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *** = \( p \leq .001 \). Standard Deviations appear in parenthesis below means.

PCI Comparison Analysis Across Sections and Effect Sizes

A two-sample t-tests was used to determine if the experimental group would outperform the control group on the PCI assessment. The results, See Table 17, show that the experimental group did do significantly better on the post-PCI than the control group (\( p < 0.01 \)). Using Cohen’s \( d \) as the measurement of effect sizes, students in the experimental group had an effect size of 0.703, indicating a medium, yet close to a large effect size, gains on the PCI assessment by being exposed to the intervention lessons compared to their counterparts in the control group.
These results show that overall, students who participated in the experimental section, achieved higher marks and achievement gains than did students who were in the control group.

Table 17

<table>
<thead>
<tr>
<th>PCI Averages Post-Intervention</th>
<th>M</th>
<th>SD</th>
<th>t</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (A)</td>
<td>5.346</td>
<td>2.279</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Group (B)</td>
<td>3.7930</td>
<td>2.144</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference (A-B)</td>
<td>1.55</td>
<td>2.324</td>
<td>2.603**</td>
<td>53</td>
</tr>
</tbody>
</table>

Note. **= \( p \leq .01 \).

Quantitative Analyses for Research Question Two

The quantitative data presented in this section will address the following research question: How are student’s views about mathematics affected in a course centered around culturally relevant pedagogy? This section will begin with an analysis on how students performed on the Views About Mathematics Survey (Carlson, 1997; Carlson et al., 1998), followed by a quantitative analysis on how this survey coincides with students’ performance in several components of the course, along with the overall course results from research question one.

Views About Mathematics Survey Analysis

To determine if the intervention had an effect on students’ perceptions of mathematics, the Views About Mathematics Survey (VAMS) was administered and analyzed. At the beginning of the course, students completed the VAMS to establish a baseline of how they viewed the subject of mathematics. At the end of the semester, their responses were then categorized as expressing expert, mixed, or folk views in accordance to the classification taxonomy put forth by Carlson et al. (1998). In doing this, some of the responses were reverse coded in order to maintain direction; for ease of analysis. Once the responses were classified, the number of responses in each category was counted to determine whether the students fell in to
the category of expert, upper transitional, lower transitional, or naïve views about mathematics. These responses gauged students’ views about the teaching, learning, and practice of mathematics.

An example of how a student was classified can be found by considering a student in the experimental group, Jamie Cohen (pseudonym). As a reminder, from chapter three, respondents to this survey responded to a statement, such as: “When I experience a difficulty while studying mathematics;,” in which respondents weighed their level of agreement with two contrasting statements, a) I immediately seek help, or give up trying; or b) I try hard to figure it out on my own. Students were responding with a single number one through eight. Numbers one through three were answers that had more support for response choice “a” than choice “b.” Numbers five through seven were more in favor of response “b” than “a.” Selecting four meant you were equally supporting “a” and “b,” while a response of eight indicated you thought neither “a” or “b” were supportive of your views for the statement with regards to the two answer choices you had to choose from.

Jamie’s survey showed she had selected eight expert responses, eight mixed responses, and six folk responses, placing her into the lower transitional classification. Table 18 contains the eight responses that revealed Jamie’s naïve views about mathematics. Question seven shows her inability to persist whilst doing difficult mathematics problems, resulting in her either seeking help without much thought or giving up immediately. Similarly, questions 24 and 25 continuously shows her frustration in solving mathematics problems because she feels that when she makes failed attempts at coming up with a correct solution, she feels incompetent; while a true mathematician would simply move towards a correct solution. Even when she goes through course materials, she still struggles with solving problems, as shown by question 12. Questions
13 and 20 speak to how she views real-world mathematics problems without regards to the context. She immediately seeks to represent symbolically what is happening without modelling or viewing what is going on in the problems, which feeds into her ideals that these real-world problems lead to exact solutions and not approximations.
### Table 18

**Items in Which Jamie Showed “Folk Views” About Mathematics**

<table>
<thead>
<tr>
<th>Item</th>
<th>Jamie’s response</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. When I experience a difficulty while studying mathematics:</td>
<td>1</td>
</tr>
<tr>
<td>a. I immediately seek help, or give up trying.</td>
<td>{Expert View: options 6-7; Mixed View: options 5; Folk View: options 1-4}</td>
</tr>
<tr>
<td>b. I try hard to figure it out on my own.</td>
<td></td>
</tr>
<tr>
<td>12. After I go through a mathematics text or course materials and feel that I understand them:</td>
<td>5</td>
</tr>
<tr>
<td>a. I can solve related problems on my own.</td>
<td>{Expert View: options 1-2; Mixed View: options 3; Folk View: options 4-7}</td>
</tr>
<tr>
<td>b. I have difficulty solving related problems.</td>
<td></td>
</tr>
<tr>
<td>13. The first thing I do when solving a real world problem that involves mathematics is:</td>
<td>5</td>
</tr>
<tr>
<td>a. represent the situation with sketches and drawings.</td>
<td>{Expert View: options 1-3; Mixed View: options 4; Folk View: options 5-7}</td>
</tr>
<tr>
<td>b. apply general problem solving techniques.</td>
<td></td>
</tr>
<tr>
<td>20. When they represent relationships in the physical world, mathematical functions are:</td>
<td>1</td>
</tr>
<tr>
<td>a. exact expressions of what is being represented.</td>
<td>{Expert View: options 6-7; Mixed View: options 5; Folk View: options 1-4}</td>
</tr>
<tr>
<td>b. approximate expressions of what is being represented.</td>
<td></td>
</tr>
<tr>
<td>24. For me, making unsuccessful attempts when solving a mathematics problem is:</td>
<td>6</td>
</tr>
<tr>
<td>a. a natural part of my pursuit of a solution to the problem.</td>
<td>{Expert View: options 1-2; Mixed View: options 3; Folk View: options 4-7}</td>
</tr>
<tr>
<td>b. an indication of my incompetence in mathematics.</td>
<td></td>
</tr>
<tr>
<td>25. When solving a challenging mathematics problem, a mathematician:</td>
<td>5</td>
</tr>
<tr>
<td>a. makes many incorrect attempts.</td>
<td>{Expert View: options 1-2; Mixed View: options 3; Folk View: options 4-7}</td>
</tr>
<tr>
<td>b. moves directly to a correct solution.</td>
<td></td>
</tr>
</tbody>
</table>
Students completed a post-VAMS survey on the last day of their regularly scheduled class. A frequency tabulation of the classification of both pre- and post-VAMS responses from the experimental group and the control group can be found in Table 19. The results show that both classes are very similar with regards to the number of students placed in each classification. For the pre-VAMS, the experimental group had 28% of participants classify as either expert of upper transitional while the control group had 38% of participants in these classifications. On the “folk” side of the scale, pre-VAMS experimental groups held 72% classifications as lower transitional or naïve whereas the control group had 62% of participants. Post-VAMS results show a slightly wider gap between experimental and control groups. We can see that 48% of the experimental group are now housed as expert of upper transitional while only 33% of control groups are in these classifications.

Table 19

<table>
<thead>
<tr>
<th>Survey</th>
<th>Expert Classification</th>
<th>Upper Transitional Classification</th>
<th>Lower Transitional Classification</th>
<th>Naïve Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Experimental</td>
<td>4 (16%)</td>
<td>3 (12%)</td>
<td>9 (36%)</td>
<td>9 (36%)</td>
</tr>
<tr>
<td>Pre-Control</td>
<td>5 (21%)</td>
<td>4 (17%)</td>
<td>7 (29%)</td>
<td>8 (33%)</td>
</tr>
<tr>
<td>Post-Experimental</td>
<td>7 (28%)</td>
<td>5 (20%)</td>
<td>5 (20%)</td>
<td>8 (32%)</td>
</tr>
<tr>
<td>Post-Control</td>
<td>2 (8%)</td>
<td>6 (25%)</td>
<td>9 (38%)</td>
<td>7 (29%)</td>
</tr>
</tbody>
</table>

*Note: Experimental (n = 25); Control (n = 24)

These findings show that the experimental group experienced positive shifts from folk views about mathematics to more expert-like views about mathematics from the pre- to post-survey, whereas the control group showed a slight decrease – but overall remained fairly
consistent. A two-sample t-test was conducting using the average change in VAMS score from pre- to post-intervention to see if the experimental group would see a significantly higher change than the control group. The results of the two-sample t-test showed that there was no significant difference between the two groups ($p = .0533$). It is noteworthy to mention that the average change in the experimental group was 0.4 and the control group was –0.125. A change like this indicates that the experimental group, on average, saw an increase in their attitudes about mathematics nearly half a classification, while the control groups’ views remained fairly constant.

To explore the phenomena seen in the experimental group in other ways, a Pearson correlation analysis was conducted among students’ change in VAMS score, final grades, and change in PCI scores (see Table 20). It was hypothesized that there would be a positive correlation between a students’ final grade and their change in VAMS score from pre- to post-test. Using Cohen’s standard for this analysis, there was a significant positive correlation between Change in VAMS Score and Final Grade ($r = 0.60, p = .0018$). The correlation coefficient between Change in VAMS Score and Final Grade was 0.60 indicating a large effect size. This indicates a larger increase from the pre-VAMS score to the post-VAMS score is correlated with higher students’ final grade. There was also a significant positive correlation between PCI Score Change and Final Grades ($r = 0.3132, p = .04$). The correlation coefficient between the PCI Score Change and Final grade was 0.3132, indicating a small effect size. This suggests as the PCI score change increases, the final grade will also increase. There was not a statistically significant correlation between PCI score change and VAMS score change.
A preliminary regression analysis was also conducted to assess if the final grade and PCI change variables were a significant predictor of the VAMS score change. The regression of final grades on VAMS score change was significant, $F(1, 22) = 12.62, p = 0.0018$. The results showed that a student’s final grade was a significant predictor of how a student changed on their VAMS throughout the semester, $B = 5.87$ (see Table 21). A regression was also completed on VAMS score change and PCI score change, expectedly, they did not show significance, $F(1,23) = 0.06, p = .8138$.

To examine how the final grades in the experimental group interacted with the students’ classifications on the VAMS post-survey, we look to Figure 6. As we can see, students who earned a grade of A had either upper transitional or expert views about mathematics. Students who earned a grade of B were more varied in their views about the subject. B-grade earners can be seen having views of all four VAMS classifications. On the opposite end of the spectrum, students who earned either a C, D, or F had classifications mostly in either lower transitional or naïve. Fisher’s Exact test for independence (Ludbrook, 2008; Mehta & Senchaudhuri, 2003) was performed to examine the relation between students’ final grades and VAMS classifications on
the post-VAMS in the experimental group. The relationship between these variables was significant, Fisher’s Exact (25); \( p = 0.002 \). Students who had higher VAMS classifications (expert and upper transitional) were more likely to have higher grades in this course than were students who had lower VAMS classifications (lower transitional and naïve).

![Figure 6. Experimental group results: Final grade versus post-VAMS classification.](image)

**Changes Amongst Individual Questions on the VAMS**

Of those 33 questions on the VAMs survey, participants in the experimental course collectively shifted on 20 of them in their views towards having an expert-like view to thinking about mathematics. Of these 20 responses, seven of them were found to be statistically significant (pre-VAMS to post-VAMS). Those seven items can be found in Table 22. These items are presented showing the more “folk” view response in choice “a” with choice “b” being more “expert.” Students in this section did have negative gains on their views about mathematics on 12 of the items; however, none of these were negatively statistically significant.
Items six, eighteen, and twenty-five were all concerned with students’ persistence in mathematics. Perhaps it is possible that after participating in this course, which had students encountering mathematics in contexts not explored using mathematics before seems to have had some effect on them being able to change not only the way they viewed mathematics, but also how they wanted to persist in doing mathematics. These students learned to continue putting forth effort, be it wrong initially or not. These were skills that were practiced during the course, especially via the intervention activities. They were also able to realize that mathematics was not just an “I do, you do” exercise, but a transferring of skills practiced in one context that can be used in other contexts and contents.
<table>
<thead>
<tr>
<th>Table 22</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VAMS Items in Which Experimental Group Showed Significantly Positive Gains</strong></td>
</tr>
<tr>
<td>6. For me, doing well in mathematics courses depends on:</td>
</tr>
<tr>
<td>a. how well the teacher explains things.</td>
</tr>
<tr>
<td>b. how much effort I put into studying.</td>
</tr>
<tr>
<td>7. For me, the relationship of mathematics courses to everyday life is usually:</td>
</tr>
<tr>
<td>a. hard to recognize.</td>
</tr>
<tr>
<td>b. easy to recognize.</td>
</tr>
<tr>
<td>18. How well I do in mathematics exams depends on how well I can:</td>
</tr>
<tr>
<td>a. recall material in the way it was presented in class.</td>
</tr>
<tr>
<td>b. do tasks that are somewhat different from ones I have seen before.</td>
</tr>
<tr>
<td>25. When solving a challenging mathematics problem, a mathematician:</td>
</tr>
<tr>
<td>a. moves directly to a correct solution.</td>
</tr>
<tr>
<td>b. makes many incorrect attempts.</td>
</tr>
<tr>
<td>30. Graphing calculators and computers:</td>
</tr>
<tr>
<td>a. speed up problem solving using established methods</td>
</tr>
<tr>
<td>b. bring new methods for solving mathematics problems.</td>
</tr>
<tr>
<td>31. In solving mathematics problems, graphing calculators or computers help me:</td>
</tr>
<tr>
<td>a. obtain numerical answers to problems.</td>
</tr>
<tr>
<td>b. understand the underlying mathematical ideas.</td>
</tr>
<tr>
<td>32. I answered all the questions in the survey:</td>
</tr>
<tr>
<td>a. without thinking seriously about them.</td>
</tr>
<tr>
<td>b. to the best of my ability.</td>
</tr>
</tbody>
</table>

**Quantitative Analyses for Research Question Three**

The quantitative data presented in this section will address the following research question: *How do students enrolled in a college algebra course at a historically Black university define and describe their culture and their experiences with lessons designed to be culturally relevant?* This section will begin with an analysis on how students in the experimental course responded on two subsections of the Youth Survey on Race and Mathematics (YSRM) that they completed on both the pre- and post-surveys, followed by a comparison of several of these statements. Some statistical testing will also be presented that considers associations with
demographic characteristics and the responses. I will conclude this subsection with some remarks comparing the post-survey with the pre-survey responses for the experimental course. After discussing the experimental group, I will discuss the same information for the control group and their responses to the YSRM surveys concluding with a comparison of the two groups. To end the analysis of results for research question three, a summary of the findings is provided.

**Responses to Questions About Students’ Attitudes About Mathematics and Race – Stereotype Questions (Experimental Group)**

Students responded to five items that were trying to gauge their realizations on how they perceived people of their race (Black/African-Americans) experiencing mathematics. They were asked to provide their agreement level from a five-point Likert scale – strongly disagree, disagree, neither disagree or agree, agree, or strongly agree – to how they related to each statement.

**Statement: People of my race are typically good at math (see Figure 7).** The responses on both the pre-survey and post-survey virtually stayed the same. There was a slight shift, in that one of the “strongly agree” responses moved to the “agree” response and one of the “disagree” responses moved to the “strongly disagree” category. The same number of respondents were still neutral about this statement. This indicates that this sample was very mixed about whether they felt African Americans were “typically” good at mathematics.
Figure 7. Pre- and post-YSRM Statement: People of my race are typically good at math.

Statement: Black people are given as many opportunities to succeed in mathematics as people of other races (see Figure 8). After the intervention, students disagreed slightly more by 8%. Instead of strongly disagreeing by 16%, that number was cut in half, but absorbed by the “disagree” option. Fewer students agreed or strongly agreed with the statement by 4% each. Overall, students disagreed more by 12%.

Figure 8. Pre- and post-YSRM statement: Black people are given as many opportunities to succeed in mathematics as people of other races.
Statement: Adults of my race use math in their daily lives (see Figure 9). The shift in the students who disagreed or strongly disagreed that adults of their race used mathematics in their daily lives was cut in half (40% to 20%). Students now seem to agree, in some form, that African-Americans use mathematics daily. The difference between those who agreed with this statement than those who disagreed with it increased by a massive 38%.

![Figure 9. Pre- and post-YSRM statement: Adults of my race use math in their daily lives.](image)

Statement: Blacks/African Americans are held back in math because of their race (see Figure 10). The number of students who responded on each level of agreement did so the exact same way on the post-survey for this statement. Responses remain unchanged from pre- to post-survey indicating that students’ views on if Black students are held back in mathematics because of their race virtually remain unchanged from activities done in this section of the course. Fifty-two percent of students disagreed or strongly disagreed with this statement. The remaining 36% of students were not sure of this statement. This could indicate that these students have not experienced or seen this form of discrimination from teachers within a mathematics classroom (or believe that this happens with African American students).
Figure 10. Pre- and post-YSRM statement: Blacks/African Americans are held back in math because of their race.

Statement: Asian Americans are better in math than people of other races (see Figure 11). Responses on the pre-survey to the post-survey remained in the same direction. Students on the pre-survey agreed more by 12% that this stereotype was true, but on the post-survey, students agreed even more than they disagreed by 24%. The number of students who were unsure rose pre- to post-survey by 20%, indicating more hesitance to dismiss such a claim.

Figure 11. Pre- and post-YSRM statement: Asian Americans are better in math than people of other races.
Summary of Pre- and Post-Survey Comparison of Responses to Questions About Students’ Attitudes on Mathematics and Race – Stereotype Questions (Experimental Group)

Students in the experimental course had similar responses when comparing pre- and post-YSRM surveys to the statements: “People of my race are typically good at math” (Figure 7) and “Blacks/African Americans are held back in math because of their race” (Figure 10) The first statement resulted in the same number of students who agreed and disagreed with it on the pre- and post-survey. This indicates that students are divided on what to think about African-Americans and their ability to do mathematics before and after the intervention. For the next statement, the responses on the post-survey were an exact mirror of the pre-survey, yet mirroring a level of disagreement over agreement by 40% that African-Americans are held back in mathematics because of their race.

Students also changed in how they thought about the “Asian are good at math” stereotype (Figure 11). The percentage of students who disagreed with this statement on the pre-survey was 12%; however, this metric reverses for the post-survey, by students agreeing with the myth 24% more than disagree. Looking solely at students who agreed of strongly agreed with the myth on the pre-survey to the post-survey, that percent dropped by 4%, while the disagreements was cut in half to 16%. More students, almost half, were now unsure what to think about Asian-American’s ability to do mathematics compared to students of other races.

**Stereotype frequency statistical analysis of post-surveys.** In this next section, statistical analyses of the post-intervention survey responses for the experimental group is presented. Findings and possible explanations based on theory for the changes in students’ views on these various stereotypes about mathematics and race are provided.
The largest difference between the number of students who agreed versus disagreed to some extent was with the statement “Adults of my race use math in their daily lives” (Figure 9). A vast majority of respondents, 60% agreed with this statement, which is 40 percentage points higher than those who disagreed with this statement. However; only 20% of these students believe that people of their race were actually good at mathematics and half of this group had no clue as to how assess the mathematical ability of African-Americans (see Table 23).

Table 23

*Crosstabulation of YSRM Stereotype Items on Daily Math Use and Performance in Math*

<table>
<thead>
<tr>
<th>Adults of my race use math in their daily lives.</th>
<th>Disagree / Strongly Disagree</th>
<th>Not Sure</th>
<th>Agree / Strongly Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disagree / Strongly Disagree</td>
<td>n 4</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>%</td>
<td>16%</td>
<td>8%</td>
<td>0%</td>
<td>24%</td>
</tr>
<tr>
<td>Not Sure</td>
<td>n 8</td>
<td>5</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>%</td>
<td>32%</td>
<td>20%</td>
<td>0%</td>
<td>52%</td>
</tr>
<tr>
<td>Agree / Strongly Agree</td>
<td>n 1</td>
<td>2</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>%</td>
<td>4%</td>
<td>20%</td>
<td>12%</td>
<td>24%</td>
</tr>
<tr>
<td>Total</td>
<td>n 13</td>
<td>9</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>%</td>
<td>52%</td>
<td>36%</td>
<td>12%</td>
<td>100%</td>
</tr>
</tbody>
</table>

From the responses in this sample, we can see that a majority of students believe that Black people are not held back in mathematics, by a tally of 52% some level of disagreement versus 12% some level of agreement, but over half of the students also believe that African-Americans are not given as many opportunities to succeed in mathematics as people of other races. African-Americans being held back in mathematics because of their race and/or not given as many opportunities to succeed in mathematics are two discriminatory acts that may manifest itself through overt or covert ways (DeCuir-Gunby & Gunby, 2016). Nearly a fourth to more
than a third of these respondents (24% – 36%) are also unsure of the level of discriminatory practices as well.

A crosstabulation of the two survey responses (see Table 24) was created in order to see this complex nature of perceived racial discrimination in mathematics. To see where the overlap is between these two constructs, Table 24 shows that over a fourth of the class do not believe that African-American students are held back in mathematics because of their race but they also do not believe that Black students are given as many opportunities to succeed in mathematics as people from other races. Only 16% of the students agreed that Black people had equal opportunity to succeed and Black people were not discriminated against. Another 16% disagreed that the opportunity was held for Black students, but were not sure if Black students were held back in mathematics solely because of their race.

Table 24

<table>
<thead>
<tr>
<th>Crosstabulation of stereotype items on discrimination and opportunities in math</th>
<th>Blacks/African Americans are held back in math because of their race.</th>
<th>Disagree / Strongly Disagree</th>
<th>Not Sure</th>
<th>Agree / Strongly Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black people are given as many opportunities to succeed in mathematics as people of other races.</td>
<td>Disagree / Strongly Disagree</td>
<td>n</td>
<td>7</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Not Sure</td>
<td>n</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Agree / Strongly Agree</td>
<td>n</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>n</td>
<td>13</td>
<td>9</td>
<td>3</td>
<td>25</td>
</tr>
</tbody>
</table>

A common and pervasive stereotype in America paints Asian and/or Asian-American students as having a superior ability in science, technology, engineering, and mathematics
(STEM) subjects (Shah, 2017). A total of 40% of students believed that this stereotype was valid – an entire 24% higher than those who were in disagreement. Even more staggering was the number of respondents who did not know if this was true or not, 44%. This somewhat aligns with the response that only 24% of respondents thought that African-American students were typically good in math (and the 52% who were unsure of this statement). Possibly for these students who thought the “model-minority” stereotype was true, if African-Americans were not good at mathematics, then from their perspective, the race of students who were “typically good at mathematics” belong to the Asian-American population.

**Analysis of post-YSRM stereotype questions by demographic information.** Fisher’s Exact tests were performed on the five stereotype statements with demographic information to see if any of these statements were significantly independent of one another. The demographic information included gender, age, year in school, final grade in course, major (STEM/non-STEM), and first time taking the course. A significant indicator was found for just one item with one demographic characteristic, “Black people are given as many opportunities to succeed in mathematics as people of other races” with “Major (STEM/non-STEM)” (see Table 25). It is also important to note that these correlation tests were run on the pre-surveys, as well, yet they returned no significance (nor approached significance) on any of the survey and demographic items/responses. Findings from Table 25 will be discussed in the next section.
Table 25

Crosstabulation of Major and Opportunities to Succeed in Math

<table>
<thead>
<tr>
<th>Statement</th>
<th>Major</th>
<th>n</th>
<th>row %</th>
<th>col %</th>
<th>cell %</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Black people are given as many opportunities to succeed in mathematics as people of other races.</strong></td>
<td><strong>Disagree / Strongly Disagree</strong></td>
<td>13</td>
<td>60%</td>
<td>40%</td>
<td>60%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>5</td>
<td>8</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>row %</td>
<td>66.67%</td>
<td>61.54%</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>col %</td>
<td>26.67%</td>
<td>80%</td>
<td>52%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cell %</td>
<td>20%</td>
<td>32%</td>
<td>52%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Not Sure</strong></td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>row %</td>
<td>66.67%</td>
<td>33.33%</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>col %</td>
<td>26.67%</td>
<td>20%</td>
<td>24%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cell %</td>
<td>16%</td>
<td>8%</td>
<td>24%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Agree / Strongly Agree</strong></td>
<td>15</td>
<td>10</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>row %</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>col %</td>
<td>24%</td>
<td>0%</td>
<td>24%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cell %</td>
<td>60%</td>
<td>40%</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fisher’s Exact (25); *p* = 0.033

**Statement:** *Black people are given as many opportunities to succeed in mathematics as people of other races.* When analyzing this statement further by major, some very interesting findings came to light. The association between the major of students in the experimental course and the belief that Black people are given as many opportunities to succeed in mathematics was significant (Fisher’s Exact (2, *n* = 25), *p* = 0.033). The value for Cramer’s V is 0.515, which indicates a medium effect size. STEM majors were more likely to disagree with the statement that Black people are given as many opportunities to succeed in mathematics as people of other races than were non-STEM majors in this sample. For this statement, 80% of the STEM majors in the class disagreed with the statement, compared to only 26.67% of the non-STEM majors. Most (40%) of the non-STEM majors agreed with the statement while none of the STEM majors agreed with the statement. This is an interesting concept, because there are STEM majors who will (more than likely) need to take additional mathematics courses who believe that Black
people have not had the same number of opportunities to succeed in mathematics as people of other races. This suggests that these STEM majors may have been discriminated against in their prior mathematics classes or they have seen other students be discriminated against. Placed in context, STEM majors typically have to take up to Calculus 1 at this particular university. These students were placed into this remedial mathematics course, which they more than likely took similar courses in high school. The lack of opportunity could have come from their own previous teachers which led to them needing to retake such a course in their college years.

Responses to Questions About Students’ Attitudes About Mathematics and Race – Stereotype Questions (Control Group)

Findings from the survey responses in the control group, followed by analyses to determine if there are any patterns and relationships amongst the responses are presented in this section.

Statement: People of my race are typically good at math (see Figure 12). On both surveys, respondents collectively agreed more than disagreed with the post-survey showing a slightly stronger agreement by 5%. The post-survey also showed a slightly higher increase in students not being sure whether they felt that African-Americans are typically good at mathematics. Overall, results from pre- to post-survey remained fairly constant for the control group.
**Figure 12.** Pre- and post-YSRM statement: People of my race are typically good at math.

**Figure 13.** Pre- and post-YSRM statement: Black people are given as many opportunities to succeed in mathematics as people of other races.

**Statement:** Black people are given as many opportunities to succeed in mathematics as people of other races (see Figure 13). The responses that students gave on whether they thought the opportunity that Black people were given in mathematics did decrease from pre- to post-survey by 11%. An additional 4% of respondents agreed with this statement on the post-survey. The number of unsure responses also increased by 4% from pre- to post-survey. The
number of students who disagreed with this statement was cut in half on the post-survey from the pre-survey culminating in that overall all 11% drop of disagreement on some level.

**Statement: Adults of my race use math in their daily lives (see Figure 14).** Overall the percentage of people who agreed with this statement rose by 8%, leading to an overall level of agreement over disagreement at 9% from pre- to post-survey. The other shifts came from the unsure respondents, who decrease by 4% and the disagree camp, which also saw a 4% drop. Overall, students agreed more than adults of their raced used mathematics more pre- to post survey, with a majority of respondents.

![Figure 14](image)

*Figure 14. Pre- and post-YSRM statement: Adults of my race use math in their daily lives.*

**Statement: Blacks/African Americans are held back in math because of their race (see Figure 15).** From pre- to post-survey for the control class, students increased overall rates of agreement by nearly 18%. Fewer students disagreed with the statement that African-Americans are held back in mathematics due to their racial category. This decrease in disagreement was by nearly 16%. Due to these shifts, the pre-survey saw an overall disagreement that was 33%, while the post-survey saw equal disagreement and agreement. A quarter of the students on both the pre- and post-surveys remained unsure about this statement.
Figure 15. Pre- and post-YSRM statement: Blacks/African Americans are held back in math because of their race.

Figure 16. Pre- and post-YSRM statement: Asian Americans are better in math than people of other races.

Statement: Asian Americans are better in math than people of other races (see Figure 16). The pre- and post-surveys showed no overall change, as on both surveys, the sample agreed 17% more than disagreed with this statement. There was a slight change within each response, as percent of student who either disagreed or agreed with these statements both
decreased by 4%. An additional 8% of respondents became unsure of how they felt about this stereotype about Asian-Americans.

**Summary of Pre- and Post-Survey Comparison of Responses to Questions About Students’ Attitudes on Mathematics and Race – Stereotype Questions (Control Group)**

In this next section, I will summarize my findings for the control group’s pre- and post-YSRM surveys. Statistical analyses were computed to test for independence on survey items with demographics questions; however, no correlations were found to be significant or approached significance for the control group.

Respondents in the control group for the YSRM surveys had similar responses from the pre- to the post-surveys. The responses that remained the same overall were the responses dealing with the statement “People of my race are typically good at mathematics” (Figure 12) – which saw a 5% decrease in disagreement. The rate of agreement with this statement stayed the same. For the statement “Black people are given as many opportunities to succeed in math as people of other races” (Figure 13) saw an overall decrease in disagreement by 7% paralleling an increase in agreement with 4%. The majority of students still disagreed with this statement on both surveys. The other question that remained fairly similar is the statement on Asian-Americans being inherently better at mathematics than people of other races (Figure 16). More students shifted from agree to not sure or disagree to not sure.

The statement “Adults of my race use math in their daily lives” (Figure 14) had a higher change, which saw a decrease in the number of those who either disagreed or were not sure by about 9%. In a course that received lessons that were well designed with high cognitive demand aspect in mind should see an increase in the applicability of the mathematics into the real world (Stein, Silver, & Smith, 1999).
The last final statement to discuss, “Blacks/African-Americans are held back in math because of their race” (Figure 15) was a question that showed the most overall change. To explore this phenomenon, a cross tabulation was created of this statement on the post-survey by the pre-survey version (see Table 26).

**Table 26**

*Crosstabulation of oppression (POST) by oppression (PRE) (Control Group)*

<table>
<thead>
<tr>
<th>(POST-YSRM) Blacks/African Americans are held back in math because of their race.</th>
<th>Disagree / Strongly Disagree</th>
<th>Not Sure</th>
<th>Agree / Strongly Agree</th>
<th>Total*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disagree / Strongly Disagree</td>
<td>n</td>
<td>6</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>row %</td>
<td>46%</td>
<td>38%</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>col %</td>
<td>67%</td>
<td>83%</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td>cell %</td>
<td>25%</td>
<td>21%</td>
<td>8%</td>
</tr>
<tr>
<td>Not Sure</td>
<td>n</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>row %</td>
<td>33%</td>
<td>17%</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>col %</td>
<td>22%</td>
<td>17%</td>
<td>33%</td>
</tr>
<tr>
<td></td>
<td>cell %</td>
<td>8%</td>
<td>4%</td>
<td>13%</td>
</tr>
<tr>
<td>Agree / Strongly Agree</td>
<td>n</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>row %</td>
<td>20%</td>
<td>0%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>col %</td>
<td>11%</td>
<td>0%</td>
<td>44%</td>
</tr>
<tr>
<td></td>
<td>cell %</td>
<td>4%</td>
<td>0%</td>
<td>17%</td>
</tr>
<tr>
<td>Total*</td>
<td>n</td>
<td>9</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>row %</td>
<td>38%</td>
<td>25%</td>
<td>37%</td>
</tr>
<tr>
<td></td>
<td>col %</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>cell %</td>
<td>38%</td>
<td>25%</td>
<td>38%</td>
</tr>
</tbody>
</table>

*Note: Due to rounding, percentages may not add up to 100% on row and column percentages.

This tabulation shows that of the 54% of students who initially disagreed with this statement on the pre-survey, almost half of them remained in disagreement, and nearly all of the respondents who had agreed still agree that African-Americans are held back in math because of their race. Another telling fact about this crosstabulation is that the students who initially disagreed with this statement, over half of the respondents became either unsure (38%) or moved to agree (15%) altogether. At first, it was assumed that students in a control class that did not
involve direct conversations about race would continue to have the same thoughts on the pre-
survey about race for the pre-survey. After further thought, this shift could possibly be explained
by the students seeing themselves becoming more successful in mathematics through a rigorous
course where everyone is of the same race; effectively rendering race a non-factor in their
reasoning if they are solely looking at this classroom.

Summary of Experimental Group Results with the Control Group

In the previous sections, I have explored the responses of both the experimental and control
groups for both pre- and post-YSRM surveys independently of one another. Now, I will highlight
some of the major key findings when comparing both these groups together.

1. Students in the experimental group equally agreed and disagreed that the statement
“People of my race are typically good at math” over the duration of the intervention
while the students in the control group agreed with this statement 30% over the entirety
of the course. Students in the experimental group were exposed to numerical
representations surrounding inequity in schools. These classes also involved
conversations about such sociopolitical and cultural issues that may have led students to
respond the same way on the pre- and post-survey with a quarter of the responses
disagreeing, a quarter agreeing, and half remaining unsure.

2. For the statement “Black people are given as many opportunities to succeed in
mathematics as people of other races,” students in the experimental group disagreed (8%)
more after the intervention while students in the control group disagreed (11%) less.
Again, the intervention lessons may have pushed students to mathematize everyday
practices with more of a critical lens. The control group had no such critical lessons,
possibly leading them to not think about the real-world issues that were discussed during their lessons.

3. There was a huge change (32%) in agreement levels in the experiment group for the statement “adults of my race use math in their daily lives.” This is also true of the control group, as well; however, their shift was not as big (8%). Both groups were around 60% in agreement that this was the case. It was expected that both groups would agree more with this statement after the intervention period due to the fact that the culturally relevant pedagogy lessons were grounded in high level mathematical tasks for the experimental group. The non-culturally relevant lessons for the control group were also grounded in high level mathematical tasks. Both groups saw and experienced the types of mathematics that could also be better explained using mathematics.

4. Perhaps one of the most intriguing statements that elicited conflicting views was the statement that “Blacks/African-Americans are held back in math because of their race.” The control group went from disagreeing 33% more than agreeing (54% total disagreement) on the pre-survey to equally agreeing and disagreeing at 38% on the post-survey. Over half the experimental group disagreed more than agreed (52%) on both the pre- and post-surveys that African Americans are held back in math because of their race. Discussed earlier was why students in the experimental group were conflicted with their views and beliefs between this statement with other statements (see Table 24). Beyond that, students in the experimental group disagreed with this statement 52%, while the sample from the control group disagreed 38%.

5. Another statement that warranted further discussion for the experimental group in their interesting thoughts was the statement that “Asian Americans are better in math than
people of other races.” About 44% of students agreed with this stereotype compared to 32% that disagreed. This margin widened to 24% more agreement than disagreement. This could possibly be explained by students seeing student achievement scores by race during one of the lessons and seeing that as inherent proof that the statement must be true. The control group also agreed with this stereotype by 17% more on both the pre- and post-surveys; however, 4% agreed less on the post-survey. Perhaps this is one of those more pervasive stereotypes that continues to permeate society, including the African-American community, as one of the “perks” of being a part of the “model minority.”
CHAPTER 5: QUALITATIVE RESULTS

In this chapter, the qualitative results that address research questions two, three, and four will be discussed. The qualitative data that were collected from the experimental course included the mathematics reflection journals and student interviews from eight participants (see Table 5). The mathematics reflections journals were collected after each lesson. Students responded to several prompts via an online Google Form based on the Culturally Relevant Cognitive Demand task framework (Matthews et al., 2013). The student interviews were conducted at the end of the semester. The first part of the interview included several questions about the course. The second part of the interview contained three different scenarios that were sociopolitical and/or culturally relevant in nature and students were asked to describe how they would use mathematics to help support their views about the scenarios.

Qualitative Analysis for Research Question Two: Academic Achievement

The qualitative data presented in this section addresses the following research question related to academic achievement: How are student views about mathematics affected in a course centered around culturally relevant pedagogy? The reflection journals and interviews were analyzed and several themes and subthemes were identified. These themes were derived first from prior theory on academic achievement, then from the data (DeCuir-Gunby et al., 2011). The main themes were: (1) reshaping the curriculum, (2) the role of the instructor, and (3) mathematics identity (see Table 27). A description of each theme follows.
### Table 27

**Theory-Driven and Data-Driven Codes for Research Question Two**

<table>
<thead>
<tr>
<th>Theory Driven Codes</th>
<th>Data-Driven Codes/Themes</th>
<th>Subthemes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Academic Achievement</strong></td>
<td><strong>Definition:</strong> academic gains and student learning. It is concerned with what it is that the students actually know and are able to do as a result of pedagogical interactions with skilled teachers.</td>
<td></td>
</tr>
</tbody>
</table>
| **Reshaping the Curriculum** | **Reshaping the Curriculum** | 1. Prior mathematics classroom experiences.  
2. Connections made in class aiding in understanding  
3. Equity in the classroom; getting more students more involved |
| **The Role of the Instructor** | 1. Current instructor's teaching method  
2. Prior not-so-good instructors  
3. Culture in mathematics dependent upon the teacher | |
| **Mathematics Identity** | 1. Positive mathematics attitude: Liked mathematics prior to this course  
2. Positive math attitude: Just the numbers  
3. Neutral to positive: Confidence boost  
4. Enjoyed the course after entering with negative attitudes towards mathematics | |

#### Theme One: Reshaping the Curriculum

The theme, Reshaping the Curriculum, was derived from the theory-driven code of Academic Achievement. This theme refers to teachers and instructors who tailor instruction and instructional materials for their specific students in order to support student success. It showed up throughout the student interviews in a variety of ways. From the context of this data set, three sub-themes were identified: prior mathematics classroom experiences, connections made in this class aiding in understanding, and equity in the classroom: getting more students involved. The sub-theme *Prior mathematics classroom experiences* was used to describe how the experimental classroom was “different” from previous mathematics classes students had experienced before. The second subtheme: *Connections made in this class aiding in understanding* concerns itself
with how students were able to make connections with things they were learning in this particular class and how it helped them become successful in completing this course. *Equity in the classroom; getting more students more involved* deals with what students saw in the classroom on the days of the intervention lessons and how they and other students were able to become more active participants during the classroom lessons.

**Prior mathematics classroom experiences.** Overall, students interviewed from the experimental group enjoyed the class. They commented on how the class was enjoyable for them for a variety of reasons. A major reason that surfaced through several of the interviews was the notion that this class was “different” than the previous mathematics courses they had been in before. This dialogue with Lindsey demonstrates an interaction that was similar to several of the interview participants and how previous mathematics courses lacked discussions and were “boring” to attend:

**Interviewer:** Has culture been discussed in your previous math classes?

**Lindsey:** No. Not at all.

**Interviewer:** Not at all?

**Lindsey:** We never really… There's never been a class discussion about anything culture-related or anything. It's always like, the random questions, like: “Joe has 50 acres of land” and random stuff like that. I feel like if they would have this, in high school, or if they would have incorporated more stuff like this it would get students into learning more, ‘cuz in high school where I come from, most kids really don't care about learning. They leave class. They get sent out on purpose. They're not really interested in it or being there because of the classes.
Later in the interview when Lindsey was asked if culture should be included mathematics courses at all, she responded,

**Lindsey:** Hell yeah! (Oops… sorry [laughter]). I feel like it's very relatable. I feel like anything that you can relate to, you're more interested in. So, if they [instructors] can just put more culture or more any like anything into math instead of just simple equations with stuff, it'll get kids more interested in it and like that's one thing I really liked about your class: I was always interested.

Another student, Ahshante, commented similarly to Lindsey and on how her previous classes were also void of relevant contexts and how this particular course was enjoyable:

**Ahshante:** No. It [mathematics class] was straight work. We had fun while doing it, but this year was my first year we actually got to do stuff like this. Like, I never seen this in none of my classes, which made it so fun.

**Ahshante:** In my opinion yes [culture should be discussed in math class] it do, because people don't realize until you go deep. Right. I know me and my friends we will be like “math classes boring,” you know? We can't do anything but do work! If teachers bring more stuff like this to the table, students could actually remember it. Like, I can actually remember some of the stuff we did in class just by like the we connections we did.

Students appreciated the change in the types of lessons as it pertains to the different contexts that were discussed with the mathematics. They noticed the differences between this class and previous ones they had taken. It was clear in how strongly some of the participants spoke about how they wished their previous classes could have been if the content was delivered
through a different context. One student even went as far as explaining other contexts she would like to see incorporated into a mathematics class taught in this manner:

**Jamie:** Well it [whether culture should be discussed in mathematics class] just depends on what lesson the teachers is probably talking about. So, like, if you like talking about graphing and stuff, I hope you’d make that more interesting. I hate graphs! [Laughter] But that could be a cultural thing. I’d like to see topics like how things has changed over the years or during a period of time? I could see us talking about the clothing... how people choose their hair, how to change and all that different stuff that goes with it. That's what I think a teacher could do.

**Connections made in class aiding in understanding.** Students discussed how the topics and varying contexts the mathematics was viewed through allowed them to learn the material better. Students also commented on how this course also helped them to gain a higher level of understanding of the mathematics concepts. To explain this, students first commented on the connections they were able to make with the contexts of this course. Some examples are shown here, but the construct connections will also be discussed later on in the findings related to research question three [see Qualitative Analysis for Research Question Three: Cultural Competence].

**Kanisha:** If you break it down like how you did it [culture in math class], then yes [culture should be talked about in other mathematics classrooms]. If it's just talked about just to be talking, then no. Okay? Because numbers mean a lot more than words. So sometimes people have to actually see it because seeing as believing, so they have to see it to be like “oh well you
know I never really even looked at it that way.” You know? So definitely if it's being taught this way then yes.

From the perspective of Kanisha we can see that for her, these connections that she and her peers were able to make in this class was helpful. That is why she would like to see more lessons that incorporate culture into the course design. This allows her, and students like her, to see mathematics in different ways. Jamie describes here how seeing connections helps her understand the mathematics better, as well:

**Jamie:** Yeah, especially for students like me. I mean like you like to talk about things like this [CRP lessons] so we can also be able to understand math better. So, like if you got a one student who is the I-understand-it-but-I-don't-know-where-you-go-with-it-type of student, you have to like; you [instructors] have to be more open and try to figure out that if this is not working, you gotta change it. Put some graphs in it. No, put it to a real-life situation. Go with the age group is.

Jamie points out that relevant material considers the age of students, as well as other demographic information. She knows that students will always ask the classic and timeless mathematics classroom question of “When will I ever use this in real-life?” To mitigate and to help students answer these questions, instructors need to help students make these connections.

Other students were asked if they thought other mathematics courses should include lessons like the ones that were implemented in their classrooms, students acknowledged their utility in aiding in understanding:

**Pamela:** Of course! You should always try to spice it up. Nobody, I mean, even though I'm a numbers person nobody always wants to see numbers. It's
nice to see a graph even though I suck at them. It's nice to see it's a couple of words in math problems. It helps.

**Kanisha:** If they want their students to have a better understanding, yes actually yes. To better understand the math, yes. These four [lessons] right here I think are very important.

**Equity in the classroom; Getting more students more involved.** Interview participants also commented on what they noticed as these lessons’ ability to get a variety of students (either themselves and others who are not normally vocal in class) to participate more. This was stated in various ways by students when they were asked if mathematics classes should include lessons like the lessons they were able to interact with during this course:

**Pamela:** Ummhm [yes]. Like because people that usually didn't talk in class can now talk about incarceration… people that wasn't really talking in class can now also talk about like student debt and socialize, compared to me, I’m used to being alone and not participating [during class].

**Matthew:** So, it gave other people a chance; even if math isn’t really their thing, it gave them a chance to speak up about something related. They be like “I might not know all the math, but I know how to do it, but I understand more.”

This sub-theme is not saying that by having these lessons is a panacea for immediate mathematical understanding for each and every student; however, from these statements, we can gleam that having topics that students are familiar with, within the curriculum of a course that is usually taught completely lecture-based, affords students an opportunity to be a part of classroom
discussions. This, in turn, can lead to connections with mathematics topics (that are tough for under-prepared students), which may lead to a deeper understanding of how these topics are useful.

It is important to note that not all students were enthusiastic about these lessons and how they differed from their prior mathematics courses. This will be discussed in within theme three: Mathematics Identity.

**Theme Two: The Role of the Instructor**

Students compared this course to their prior courses and how the instructor played a major part of their current beliefs about a culture-infused mathematics course and students’ mathematical identities. When projecting and envisioning themselves taking another course like this, a central figure that constantly came up was the role of the teacher and how that would (at times) be most important. Subthemes included in this theme include how the current instructor’s teaching method was appreciated, how prior teachers’ instruction compared to that of this course, and how the role culture in mathematics is heavily dependent upon the teacher who shapes the discussion.

**Current instructor’s teaching method.** Students enjoyed the teaching methods implemented in the course. They found it helpful for them to learn and understand the mathematics. They enjoyed the structure of the course, as well as the teacher’s interaction with students. Students commented on this subtheme differently at various points throughout the interview.

**Pamela:** You made [this class] easier [than my previous math classes]. Not *YOU* made easier, but the way you taught made stuff easier. Easier to
understand. Normally you have teachers talk to you the entire time, but not in this class. You helped people make connections.

**Kanisha:** I thought that the course was actually pretty informative. It was good. I’m basing it on like I already took this course before at a community college in Connecticut – and clearly, I didn’t pass it. That’s why I’m in here again now. [Laughter] What probably made the difference is that I liked your whole teaching method [this semester]. I thought it was pretty cool and it was well understood.

**Matthew:** I really liked constant practice you gave us during class, how you explained everything if we asked. You didn’t have an attitude about trying to go over everything like some teachers would. If someone really needed help, you allowed them to stay after class and work on things like that.

These students seemed very appreciative to have these traits in their teacher, which they felt aided in their success in this course.

**Prior not-so-good instructors.** Students also commented heavily on previous experiences in prior mathematics courses in which they felt their needs as learned were not adequately served by the instructor they had. These responses also came up at various points in the interviews and often seen as spontaneous utterances from participants.

**Ahshante:** I think [the difficulty of this course comparable to previous courses was] ok. It all depends on the teacher. I had rough teachers in my past where I was like, I’m not going to do the math because it's hard to learn it. But I had other teachers was like you know they actually helped me through it. We actually sat down. So, in my opinion, it all depends on the teacher.
Because if you have a teacher that's willing to work with you and willing to know your strengths in math then I feel like you guys go had a plan and work through it.

**Lindsey:** I would say [the course difficulty comparable to other previous courses] was a lot easier. Especially… I remember last year, my senior year, I took precalculus okay. I would be up till two o’clock in the morning crying, trying to do my homework. Then the math teacher I had before that, he was so awful he would get up there read it and be like, “here you go, you should know how to do this math now” and I would tell him, like, I have no idea and he would say: “I'm trying to get you prepared for college!”

This class was nothing like that.

These previous examples that some of the students described were similar to what other students stated about their previous mathematics courses. Essentially, their experiences hinged upon the environment and how teachers are at the center of that environment. Students would either literally not do work (or at last not try as hard as they probably would have) because of experiences with teachers (Ahshante) or they would be upset to the point of tears (Lindsey) due to “well intentioned” teachers trying to get them prepared for the next level of academic schooling. It is also clear that if this is the case, then this says a lot about how other teachers see the profession of education at the collegiate level – mostly lecture and disconnected from students.

Students expressed the desire to have teachers with the human traits of compassion, patience, and caring (which even some other mammals have the ability to show). Students explained that they wanted to be heard, understood, and their confusion in a mathematics class
validated and not berated. Jamie put it like this when she was asked if other mathematics classes should include culturally relevant pedagogy lessons like the course she just participated in:

**Jamie:** It's hard. In my opinion, I feel like it's all based on how a teacher gives it to a student. So, if like this student can understand it, zero times out of ten, a teacher should still try to help. But where I'm from, the teachers, they try to help students, but like – they only pick certain students, so like either you catch on or you don't if you’re not one of the chosen few.

This subtheme seems to be the “leitmotif of a sad song of disappointment” for students are constantly crying out for help and compassion, only to be derailed in their quest for understanding within the subject of mathematics. “Understanding” may not be the ultimate goal for all students, but at the least, students want to at least do well in the course they are trying to pass.

**Culture in mathematics dependent upon the teacher.** The final subtheme to be discussed under the theme of the role of the teacher came down to the question of: *Do you think culture should be talked about within the subject of mathematics at all?* All students, when asked their opinion of this question, responded by saying “yes.” This was mostly due to their experiences they had within this class, enjoying the culturally relevant lessons and finding success in a mathematics course. Some students, however, went a step further by providing a caveat: “it depends on the teacher.”

**Matthew:** Yes, if you have the right teacher. I feel like you just can’t have a teacher just talk about anything like that, because you would have to know how to talk to your students and some people might get offended with what you say. So, I feel like if you have the right teacher, who can talk about things
like that, then yes, they should be, but I wouldn’t say force it into your lesson because everyone wouldn’t be able to talk about it.”

**Kanisha:** If you break it down like how you did it, then yes. If it's just talked about just to be talking, then no. Okay, because numbers mean a lot more than words. So sometimes people have to actually see because seeing as believing, so they have to see it to be like “oh well you know I never really even looked at it that way.” You know? So definitely if it's being taught this way then yes.

For these students, they knew in order to do a class like this, it needs to be taught by someone with cultural competence towards cultures that are similar and different from their own. Students could almost imagine how the course could have gone if a teacher was not in-tune with their audience or sensitive to the topics that they were trying to discuss. Students also knew that information like this has the potential to be powerful and eye-opening (Kanisha). To squander a chance to have transformational moments for students would be a waste of a truly educational experience, one that transcends any one subject or a subject that can be taught in school.

**Theme Three: Mathematics Identity**

The third and final theme that arose from analysis of data addressing research question two, was one involving the mathematical identity of students. Several student attitude profiles (subthemes) emerged from this data, which are presented below. When describing each profile, I begin by describing who each student is in the form of a brief background. I intentionally waited until this section to do so because this is the first section that really dives into who the students are, not only as learners of mathematics, but also as humans. These descriptions offer more insight into who the students are beyond the information provided in Table 5.
**Positive mathematics attitudes: Liked mathematics prior to this course.** This profile concerns itself with students who had positive dispositions towards the subject of mathematics and who also had positive dispositions towards the culturally relevant-based course. Tiffany and Lindsey both exemplified traits that put them in this mathematics attitude profile.

Tiffany is an African-American female, first-year nursing major student who received the grade of an A in the course. She stated that mathematics is her favorite subject and she simply just “likes numbers.” She attributes this partly to her mother who also likes to do math and does so in her career. She describes herself as a “hands-on” kinesthetic learner who needs to see the mathematics that she is learning in action before she can truly feel like she understands it.

When asked about how participating in this course changed her thoughts about mathematics she enthusiastically stated:

**Tiffany:** This course made me love math even more than I actually did. Being that I like learning stuff, I was like: oh, this is easy. This is easy. I can then relate it to the real-world stuff and everything. It was great. Yeah.

She then goes on to talk about how the course also helped reaffirm her love and abilities to do mathematics. She spends a good amount of time commenting on how this course increased her confidence in mathematics and how she was, at one point, thinking about switching to a more quantitative intensive major because of it.

**Tiffany:** Yeah [this course increased my confidence to learn math] because now after this class, I’m like… I want to know more! Like, what else can you do with it? Yeah. I honestly, I had an opinion, like, maybe I should move my major from nursing to something dealing with math, but then it’s like:
not so fast! [Laughter] I think I want to stick with nursing because nursing still includes some math.

Lindsey is a bi-racial African-American and White female first-year student, who identifies herself as an African-American student. She received a grade of B at the end of the course. She states that she is self-proclaimed to “always being a ‘math-person’” who really likes math. She is not a huge fan of word problems because she has dyslexia which makes reading more difficult for her, but enjoys the subject nonetheless. Lindsey had similar experiences in the course as Tiffany. She talked more about how this course boosted her confidence to learn mathematics by stating how she would constantly look back to the culturally relevant pedagogy lessons that we did during class when she would complete her course assignments. She did this because it served as a reminder that the concepts being learned in class was actually being used in real-life. She even commented on how the topics we looked at during class and how she thinks about them in her daily life, particularly the “cuffing season” lesson and the student loans lesson.

Both of these students certainly felt as if they learned a lot of mathematics throughout the course and they enjoyed their time in the course. Both came into the course having had positive views towards mathematics and left the class feeling the same way due to the application that the mathematics afforded.

Positive math attitude: Just the numbers. Students who held this disposition loved the subject of mathematics; however, that only extended to the numbers and algebraic manipulations of it devoid of the context. Asia-La’Rae and Pamela both reiterated their wish to not be in a class where culturally relevant pedagogy is done (literally) every class period and have the majority of class time be devoted to numerical manipulations and algorithmic learning of procedures for that is the mathematics they are used to and prefer. Students come into mathematics courses with
views of how things in a mathematics course should operate (Bennett, 2015; Cobb, Yackel, & Wood, 1992; Kuhn, 2005; Mercer, 2008) and this course conflicted with those preconceived ideas about mathematics. Challenging and pushing to change these norms can be difficult.

Asia-La’Rae and Pamela are both African-American female, first-year students. Asia-La’Rae elaborates on her experience in this course in the following dialogue:

Interviewer: Do you think other math classes should include lessons like these?

**Asia-La’Rae:** Yeah, but I will say I wouldn't do too much of it. Yeah, I guess to switch something up or do this like once every unit or every few units or something like that to kind of just get a different… A change in the class and stuff, then yes. But that's not something I would do all the time in math. No.

Interviewer: So, the only ones we did were these four. Do you think that four was too much? Too little? Just the right amount? What do you think?

**Asia-La’Rae:** Ummm… I don't think it was too much. I think it was a good amount and it's not like they were back to back to back. So, it was pretty good amount for what we were doing and the time we had.

Interviewer: Yeah. Time was a huge factor. So, what would you think if we would've did like one a week?

**Asia-La’Rae:** TOO MUCH! [Laughter]. I don’t want to do that.

Asia-La’Rae’s justification for why she thought lessons like these in a mathematics class should be limited came earlier in the interview when she was asked what her least favorite part of the course was.
Asia-La’Rae: Mines was actually those days where you did the comparing, you know, to stuff going on today. Sometimes, I mean, I understood it and it most definitely worked with whatever math we were doing, but sometimes I just rather just; oh yea, know the formula or know how to do it and just do the math instead of just actual like comparing it to outside world sometimes, even though I understand it but sometime I’d just rather not do that – just get straight to the point. Do the math.

Interviewer: Okay. Talk more about these lessons.

Asia-La’Rae: Yeah… [the lessons] were all relevant, I’m just saying. They most def are important to know.

Interviewer: But you’d rather just…

Asia-La’Rae: I don’t know, sometimes I just, I don’t feel like doing that. Like say for instance, sometimes, I don’t want to answer it like, what does this graph mean, you know? I rather just… “oh yeah these are the notes for the graph Figure out those numbers and what they mean and then go about that it like… full-blown questions as if it's like reading or something of that nature because it's math and sometimes you literally want to do math numbers. That’s all.

Interviewer: So, you’d rather just have the numbers – to just work with numbers?

Asia-La’Rae: Yeah.

When pressed further about her thinking on these lessons, it was revealed that she preferred mathematics devoid of context. She prefers “just the numbers” as opposed to situations where she could actually see the mathematics being used in a real-world situation.
When asked if she thought the ways the lessons were taught helpful to Pamela, she responded:

**Pamela:** Yeah. Even though I want to just look at numbers. Even when we do stuff like this [application problems], I pick out the numbers. So, when you had stuff like this, I went right to the numbers, because I ain’t with the readings. I went straight to the numbers and started plugging it in. And plus, when I do stuff, I'm very to myself, and then I tell you what I go. But I don’t like working with people.

When pressed further about this later in the interview about if she thinks culture should be included in addition to the procedural, she states:

**Pamela:** You can throw some aspects of it in there, but as to whether you should or shouldn’t… I mean, if you pass the basics then you can add your own little sauce and twists to it, but if you talking about the basics, I think you should just learn and then once you got that, then you can add everything in there and culture can be a part of that.

Her statements say that culture (and any true application or concepts) should only be added to mathematics after procedures are learned and mastered and she would rather not have it woven throughout the lessons the way it was done in the experimental class. Although she still liked the course and felt like she learned, Pamela and Asia-La’Rae still prefers “just the numbers” devoid of and context or applications. While the majority of students interviewed did enjoy and like (to some extent) this “change of pace” in a mathematics course, not everyone found it as helpful, and that was okay for them.
Neutral to positive: Confidence boost. Participants who displayed the characteristics of this profile were students who came into the course believing mathematics was simply, “ok” or they did not particularly like or love the subject; however, they did not hate it either. After experiencing this course, their confidence in mathematics seemed to get a positive boost.

Matthew, an African-American male first-year student, was asked his thoughts about the subject of mathematics. His response, not surprisingly, was predicated on earlier experiences with mathematics. He stated that mathematics used to be his favorite subject, but when he got older, that changed due to bad experiences when attempting to take Calculus in high school. He had to withdraw from the course due to “how hard it was” and he attributed that to not having the right teacher who was capable of teaching him in the way that he preferred or the way that he could learn. He also stated that “Overall, I don’t have a problem with math. I think I’m actually good at it if I have a good teacher, but overall, it’s okay, but it’s not a big fan of mine.”

Similarly, yet digging further into the past than high school, Jamie, an African-American female first-year student, expressed how she remembered her struggles in mathematics dating back to her earliest memories being a student. She commented on how she did not particularly like the subject because of these prior experiences. When asked if the way this course was designed and delivered (with the intended purpose of culturally relevant lessons in mind) if that was helpful to her learning endeavors. She states:

Jamie: Yean. I thought this class wasn’t going to be my best class with the way things was looking and how I was feeling and I was just like, I’m not going to get through it. But I’m glad I passed… Yeah, because I’ve always had to struggle with math ever since like elementary school. And that's
always been a real problem with me, so to pass it at like a college with a

B, I’m proud of me. I did that!

She was clearly and visibly excited about her the way she was able to perform and attributes that
to this course. When asked if this course influenced her confidence in mathematics, she stated
something that surprised me for a person who did not, understandably, have the brightest of
outlooks on the subject of mathematics. She said:

**Jamie:** Definitely! Well, let me say it like this: it made me feel like I could take
another math. So, I’m going to take another and see how that goes. If I
don't pass it, imma just be like… look. That was that and there is goes!

[Laughter]

Similar to Jamie, Matthew, when answering that same question about confidence, he
stated the following:

**Matthew:** Yeah. It boosted my confidence a lot. It really started making sense. Like I
said before, it made me think I was actually good at math. It made it
easier, the more math that I did… It made my confidence go to an all-time
high.

Both students also expressed how they thought that the subject was “important” more so
than any of the other participants, which I thought was interesting.

**Matthew:** Yes, I do [think other math classes should include lessons like these]
because I feel like math is a very important subject you should have after
school in the real world, but I also thin k it should be used in real life
situations because it will open your mind up, expanding your vision,
especially with real-life situation like this that’s going on in the real world today.

Jamie: I don’t know [if I need to take another math class], but you know, I just always think it’s good to like… it’s my thing I feel like it's good to have extra math in college because, you know, math is always changing, so it’s always good to keep yourself updated and fresh. So, you'll have to keep taking all the math but it's good to like at least one or two more like you won't be behind like confused on what you learning especially like if you go into a graduate [program] and if your major is something dealing with math.

Both responses surprised me while analyzing the data. Both of these students described and acknowledged/agreed that mathematics is important. Matthew – for the purposes of being able to interact and understand it in real-life, Jamie – just to stay updated and keep your skills from being rusty. They said this in spite of their past negative experiences in mathematics, but positive experiences in this class and seeing that the mathematics they were learning being connected with the real-world and being able to see its application.

Enjoyed the course after entering with negative attitudes towards mathematics. The final two interview participants exhibited traits similar to one another that is encapsulated in this profile. These students came into the course disliking mathematics. With this negative attitude towards mathematics, neither student stated that they absolutely loathed the subject; however, they were very candid in their responses with regards to their feelings about the subject: their strong disliking of it. They also left the class still not particularly liking the subject; however, they did enjoy their time in the class and sees the importance and relevance of the subject, yet
they still “strongly dislike” the subject. Ahshante and Kanisha are most in-line with this mathematics attitude profile.

Ahshante is an African-American female first-year student who attributed her disdain for the subject to her not being able to recall procedures and concepts necessary to do well in the subject. When asked about her thoughts on the subject of mathematics she was direct with her response about why she did not like the subject.

**Ahshante:** I don't really like math because I feel like my brain… is just too many numbers and it's not something that catches my eye so I'm not really big fan of the math subject. Whenever I have to do any problem, I feel like I have to keep looking at my notes and I do not like that at all. It just doesn’t stick with me like other subjects and topics do. But yeah… I'm not really excited about math.

Kanisha is also an African-American female student; however, unlike the other participants interviewed, she is a non-traditional student. She is a 38-year-old woman, recently retired from serving in the military, with a 16-year-old son. She had the following to say:

**Kanisha:** I. Don’t. Like. Math. [Laughter]. I don’t like math. I used to like math like um in high school. I used to get As. Algebra – As. Then I went to geometry and dropped geometry and I went to accounting and I passed that. I took accounting and college and community college and I also had to take algebra too and that's where I was just like kind of lost because there was such a big gap and I was kind of disappointed in myself because I remember getting all As. So, for graduating in 1998, I started my college in 2007 – that’s a big gap. So, it’s kind of like went out the door and even;
I think I took a couple college algebra courses, so even coming back to this; like my memory is really bad. Really, really bad. So, some things was kind of familiar but a lot of things like I would still have to go back like okay yeah, I might have learned this but I know it looks familiar like I remember, you know, but I don't know how to do it. So, I had to relearn it. So, yeah…. and I'm just not good with math. I'm not a big fan of math. I don't hate it cuz I don’t’, but I'm not a big fan of math. Like if I had to choose, math would not be my number one.

For somewhat different reasons, these students still disliked the subject of mathematics. Kanisha attributed her dislike somewhat to the fact of her past success in the subject in earlier grade levels, yet when reaching higher levels of mathematics, her success diminished as well as her disposition towards the subject.

When asked if the course that they just finished taking changed their thoughts about mathematics at all, they had the following to say:

**Ahshante:** No. No, it did not. [Laughter] But while I was in class, I really liked it – the conversations and the topics. I could actually flip back now and be like: I know I learned something this semester and that’s something I couldn’t say about any math class I’ve been in before.

**Kanisha:** I would say no, but the course was helpful. Like it wasn't bad, I’m just not into math. The course was very helpful though, like very informative. I did learn, I learned some stuff. I think I'll be able to do more stuff; you know. I also think I'll be ready for the next math course I take.
These two stated how they enjoyed the class and learned from it. Ahshante went as far as to say she felt better about this class than any math class she had taken before because she felt that she actually learned something, which could potentially begin to shift her disposition in the future if she were to take another mathematics course (that is based on culturally relevant principles). Kanisha also thought the class was informative and helpful. When asked if this course increased her confidence in her ability to do math, she stated:

**Kanisha:** Well I know I can do math. I can. It’s just my comprehension is kind of slow sometimes. Yeah, I know I can do it. It’s nothing that I can’t do it, it just might take me a longer time. It might take some more research, some more learning but eventually I can do it. I don’t believe in ‘can’t.’

This statement shows that she has no issues with her abilities to do the subject, only she needs more time to process information. She just needs a different set of equitable foundations in place for her to succeed in the subject. Perhaps culturally relevant pedagogy aided her in this.

The tenets of culturally relevant pedagogy often overlap, as some of the statements made by students in this analysis of the qualitative data on academic achievement were in line with cultural competence. When materials that students engaged with utilized pedagogy that was in line with their cultures, students reported having a deeper understanding of mathematical concepts. These cultural phenomena will be explored in the next section concerning the qualitative results for research question three on how student thought about the course and its effect on students’ cultural competence.

**Qualitative Analysis for Research Question Three: Cultural Competence**

The qualitative data presented in this section will address the following research question related to cultural competence: *How do students enrolled in a college algebra course at a
Historically Black university define and describe their culture and their experiences with lessons designed to be culturally relevant? In order to address this question, I needed to gain an understanding of how students defined the word “culture” and what they believed to be components of their own culture. After an analysis of this, I will dive into a discussion on why students decided to attend an historically Black college/university, which directly tied into what they had to say about the idea of culture. This, in turn, lead directly to aspects of the course and the culturally relevant pedagogy lessons, themselves. A summary of the themes and subthemes related to research question three can be found in Table 28 below.

Table 28

**Theory-Driven and Data-Driven Codes for Research Question Three**

<table>
<thead>
<tr>
<th>Theory Driven Codes</th>
<th>Data-Driven Codes/Themes</th>
<th>Subthemes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural Competence (and Historically Black Colleges/Universities)</td>
<td>Definition: Using contexts that helps their students acquire knowledge about the structure real-world and life beyond school</td>
<td></td>
</tr>
</tbody>
</table>
| Defining Culture | 1. Culture as comfort  
2. Culture as pride | |
| Attending an HBCU | 1. Seeing people who look like yourself  
2. The "Black Experience"  
3. Support system | |
| Connect Mathematics to Real-World | Seeing Culture through Culturally Relevant Pedagogy Lessons | 1. Culturally specific  
2. Relevant and timely  
3. Pedagogically different |

**Defining Culture**

An imperative concept in culturally relevant pedagogy is the concept of “culture.” Patricia L. Marshall (2002) eloquently defines the concept in the following way:

Culture refers to the consistent ways in which people experience, interpret, and respond to the world around them; it represents the “ways of being” of a collective population.

[Some components] of culture are food, language, music, and beliefs about good and
evil... Culture is a feature of all human groups and is shaped by historical, social, political, economic, and even geographical factors. Individuals acquire culture through contacts and associations with others who share their culture such as nuclear family members, relatives, and friends. Additionally, culture can be reinforced through contacts with social institutions... (p. 8)

When asked about how they would describe their culture or cultural identity, interview participants collectively stated many, if not all, of the aspects described by Marshall. Responses dominantly centered around race more than anything. Other features of culture that respondents discussed included religion, age, relationships with family and friends, geographical locations, climate, music, and language. Primarily, these ideas are described below using the following subthemes: culture as comfort (describing how culture provides some level of comfort for these students) and culture as pride (explaining how students are proud to possess the culture they have).

**Culture as comfort.** A few of these aspects from Marshall (2002) really stood out with what students had to say. Their comments about culture reverberated the notion that culture provided them some form of comfort, in that they felt more comfortable with people from their own culture. The following comments help illustrate this theme:

**Asia-La’Rae:** I don't know... Umm... I mean, I’m Black... [laughter]. I don’t know... I’m very comfortable more so with “our own people” if that makes sense. In high school, I competitively did swimming. By doing a sport that is not a “predominantly Black sport”/African-American sport,” I've dealt with certain things, like racism, and things of that nature, you know? I had to fit in with different races – though which is cool, but, you know, it's not like
oh your own people so I'm very comfortable more comfortable versus like outside basically but I can get along with any and everybody. You’re just more comfortable with people in your own culture… Culture is also the way you do things, traditions, how you do things.

**Lindsey:** My mom’s White, so when I hang out with her side of the family it's so different than when I hang out with the people that actually raised me – my [White] mom and other Black people [from the community], I consider them the Black side of my culture. Like, with my mom's side of the family you can only say or do certain things. They barely mess with me, as it is, and I feel like if I was a little bit darker, they wouldn't even talk to me because that side of the family is really racist. And so, I feel like I grew up like shut off from the White side of my culture because like I never I never really felt loved by any of them, but whatever. But then I hang out with my – the actual people that raised me because the music we listen to is different, the way we talk to each other is different. I feel more comfortable with them.

With culture, this sense of comfort and being around people who they feel are within their own culture is a something that resonated with many students.

**Culture as pride.** Some students commented on the social aspects of culture and how they were proud to have the culture they possessed and, more specifically, the race they belonged to.

**Matthew:** It’s like, basically, what you guys usually do at all times for a race — the African-American race and things like that. If you think about culture for
African-Americans, it’s all about really having a good time, partying, barbecues. You got the fraternities and then especially the Fried Chicken Wednesdays. It’s all about having a good time and coming together as one. I truly believe being a part of this culture, we have to build each other up and enjoy ourselves because there’s so much wrong going on against us and other culture constantly trying to tear us down. We have to laugh it off or we’d be depressed all the time. We have to build “us” up because we’re dope!

**Ahshante:** African American. This tribe, this new era – like, this new age. Also, this is new variety of Black community. We’ve change from what older generations of Black looked like. Culture-wise us being powerful just as African-Americans that is culture. We’re powerful in the sense we have had to endure so much from others; yet we’re still here and strong.

**Jamie:** Well [culture] all about how we you know as African-American people act towards each other, like how we carry ourselves with so much pride. Even though we may not show it whenever someone has like has been killed – like a Black person is always being killed. I think the pride shows up when you see how many people will stand. Now you talk about pride, I see it on this campus, because whenever [name of Black student who recently was shot and killed in a near-campus apartment by security guard] got killed, everybody on campus was like this is not ok. He was a student. He shouldn't be treated with the same respect as any other student at a PWI would have been.
The lyrics to James Brown’s “Say It Loud - I'm Black and I'm Proud” (Brown & Ellis, 1968) reverberated in my head after listening to these interview sections multiple times. With regards to this feeling of pride and being proud of one’s culture (for all these respondents, the African-American culture) was powerful and invoked feelings of raw emotion. They were passionate when speaking. This notion of proudness led students justify the term, without provocation, due to the term sometime having negative connotations. Being proud and having pride for these students were entrenched in the culture that they felt a part of.

These statements from these students about culture caused many of them to think deeply about the word itself. Most of these students began this part of the interview unsure what to say. Often, they would begin their responses with the words: “I don’t know…” or “what do you mean by that?” I intentionally kept my response to the latter question and my probing of the former open and vague, usually responding with: “I know it’s a word that encompasses a lot. Just what comes to mind when you hear the word, ‘culture.’” Students then would begin to talk about race and that would lead on tangents to the other aspects of culture that were mentioned.

**Attending a Historically Black College/University (HBCU)**

This notion of culture reverberated with students’ responses about why they decided to attend an HBCU. Responses to this question included several things that would probably be true of any college, historically Black or predominately White, included, such as: it was a good school or the city and/or climate the location of the school was in. Trying to get students to dive a little deeper into why specifically an HBCU required just a little more probing, but responses were indeed interesting and similar in nature to each other in that they all revolved around race. Responses touched on race playing a major role in terms of primarily seeing people
of the same race as theirs, wanting to get the “Black/HBCU experience” and wanting a support system on their campuses.

**Seeing people who look like yourself.** Students discussed their various reasons for wanting to come to an HBCU and one theme that came up in several of the interviews was actually visiting the campus and seeing a sea of people who looked like they did. For these students, this removed any doubt they had about attending an HBCU.

Lindsey discussed how she wanted to continue to be around people who shared the same culture she identified and felt comfortable with, due to the fact that her mother’s family did not particularly like her African-American roots. She states:

**Lindsey:** So, I grew up with like all these “brothers” (that’s what I call them). And so, like their family is my family; and I felt like it would just be cool to come to an HBCU and hang out with more people like me. I came here on the tour and before it, I was like… ehhh… I was a little “iffy,” I just didn’t know. So, I came here on a tour and it just felt like home. It felt like real home-y and everyone was so friendly and I just really liked it.

For Asia-La’Rae, a campus tour also solidified her decision in this particular university. For her, she spoke on how she really wanted to be at a place with smaller class sizes and felt she would not get that at a predominately White institution. She had done her homework on HBCUs and appreciated the history and mission of HBCUs. She also discovered that all of them (except one) had total enrollment sizes of less than 10,000 students, equating to smaller class sizes and a more intimate environment. She recalled that after she toured this HBCU:

**Asia-La’Rae:** I visited and I liked it and that’s how I ended up here. I was always set on going to an HBCU so I can see more people who look like me. I was also
always set on going down south. Now I’m not really “down south” right now, but it’s kinda south. [Laughter].

Similarly, Matthew spoke of his tour visit to this university and how it shocked him, to some extent. He says:

**Matthew:** During the free application week thing and [Bernard St. Stephen University] was up there, so I just randomly applied there and I got accepted. Like, I’ve never been to an HBCU before or even on a campus where everyone was Black. At first, I didn’t really want to go here — it was between here and [a PWI], so when I got here, and saw all the Black people, I was shocked, but it immediately felt like right. I went to [the PWI] campus and it was the complete opposite. I saw very few Black people, so I knew [Bernard St. Stephen University] was better than I thought. Me and my roommate did the orientation here and that made me like it even more.

For these students, coming to an HBCU campus and seeing someone who “looked like them” was a key factor in deciding why to attend this HBCU. Without seeing these warm and inviting faces and skin tones and realizing that is what they wanted to surround themselves around for the next four years, they would have chosen to go to a different university.

**The “Black Experience.”** Students often mentioned wanting to get what Kanisha called “The Black Experience.” This takes the previous theme of seeing a campus full of African-American people a step further by becoming immersed in Black culture.

Ahshante went to a high school that was also predominantly Black which was located in the part of the city that was also composed of people who are primarily African-American. Her
high school and Bernard St. Stephen University are located mere minutes apart from each other, to the extent that organizations in which students attending Bernard St. Stephen University would frequently be associated with the high school as a form of either community service and/or mentorship opportunities. For her, having been a part of a school culture that was dominated by African-American culture, she could not see herself wanting to change from that experience, hence why she chose an HBCU. She states: “it is honestly a home away from my home – which is only like 3 miles up the road. [Laughter].”

In contrast to Ahshante, Pamela did not go to a primarily Black high school. She had the complete opposite experience by attending predominately White and private elementary and secondary schools growing up.

**Pamela:** I went to a private elementary school until fifth grade I went to a predominantly White school from six to twelfth grade, so I was surrounded by White people my entire life and then my friend, my best friend, was like: “you’re White in your soul” and then it's like, she got to know me more and then it's like, “okay there’s your Black side.” That kinda stuck with me. I knew I wanted to be around people who looked like me, and I figured there wasn’t a better place to do that than an HBCU. For her, prior experiences prompted this feeling for her to eject herself from the environment that she had been in, into an environment that was the complete opposite. An environment that was full of the culture that she identified herself with.

**Support system.** Some respondents reported their reasons for wanting to attend an HBCU because of the natural and organic support system that is contained on a campus of an HBCU. Students had this to say about this (and other) HBCUs:
**Tiffany:** And then also Bernard St. Stephen University is a great HBCU and it's connecting with like, my culture. Having people help me – like Black people helping Black people – that’s what actually happens and that great.

**Jamie:** Well, I would be the first person in my family to attend a historically Black college/university. My sisters attended two PWIs. My decision to come here was based off their decision. I wanted to be around my own culture because I'm born in this time period where there's a lot of mass incarceration and people being killed for the wrong reasons and being sent to jail for the wrong reasons. And so, whenever you go to HBCU, you are around people who are going through the same things or have been through it too recently. Y’all can connect with each other.

Having a support system for when situations happen in everyday living, or that you feel are unjust was an important factor in these students’ decision for attending an HBCU. Having an entire campus versus just one sole organization on a campus at a predominantly White institution factored into the equation of attending an HBCU.

**Seeing Culture through Culturally Relevant Pedagogy Lessons**

Having an understanding of how students view what their culture actually is, this helps explain why they chose to attend an HBCU to begin with. These concepts coupled with each other also help explain why the students thought of the course the way they did. Students expounded and elaborated on how these culturally relevant pedagogy lessons were 1) culturally specific, in that they allowed students to make connections with their own lives; 2) relevant, in that these lessons were delivered at the right time and to the right audience; and 3) pedagogically different than what they had experienced in previous mathematics courses.
**Culturally specific.** Students commented heavily on how they enjoyed the lessons and thought that this course was unique given the connections they were able to make with their day-to-day lives and how it pertained to topics in their culture, other’s culture, and experiences. Many of the statements about the course and/or lessons themselves are akin to what Lindsey said when asked about her thoughts on these lessons and how it related to the subject of mathematics:

“When [math] relates to me, I'm more into it. All of these like touched some part of my culture. Like, I was really into it and the discussions you led us and talk about it, it was really helpful.”

**Culture and race: Incarceration and linear functions.** Students included constructs such as race in their definition of their cultural identities. A vast number of statements made about the culturally relevant pedagogy lesson on incarceration and its relationship to linear functions and their graphs will be discussed in later sections as they refer more to themes regarding a sociopolitical consciousness (see Results on Research Question Four: Sociopolitical Consciousness). With regards to the cultural context and content of this lesson and less of a focus on the sociopolitical, students enjoyed how this lesson made them think. They were able to see connections between their real-lives, cultural experiences, and the mathematics they were currently learning. Take Lindsey for example. She commented on how this particular lesson really stood out to her due to things she was dealing with in her personal life.

**Lindsey:** I liked [the intervention lessons]. I feel like when you related the incarceration and race, that got us all more like into it, the math, because we can all relate to that and like we know people who are in jail, so I feel like that lesson got us really into it and we had a great class discussion.

**Culture and age: Health and quadratic functions.** Many comments were also made about the lesson surrounding health issues. Students remarked on how this lesson really
resonated with people their age and with people living on a college campus. Age and geographical locations were two aspects that students also included as a part of their culture.

**Pamela:** They’re important. These lessons are super important. Especially for freshmen, you know? They get here and they just nasty! They do and want everything. They want to experience everything and it’s too much. They need to hear this so they think twice about some of the decisions their nasty-asses are making. [Laughter].

**Matthew:** And with the STDs and stuff, it helps you want to be more smart with the things you want to do because you never know what somebody else has. They might not tell you and all it takes is a little touch and they could pass it on to you and now you have it and it’s a big deal going around many colleges these days.

These two students talked about how the lesson on health and quadratic functions was appropriate for college students and how it could also be a cautionary tale for incoming students. Some students went further and specified how they felt this lesson was really meant for students specifically attending an HBCU.

**Asia-La’Rae:** I would definitely say the STD and cuffing season lesson [talked about my culture]. I feel like that was very important for our culture, African-Americans. Knowing about the STDs and how that’s going, age-wise. [Interviewer asks her does it connect to other cultures]. Well… honestly, it addresses everyone because anybody and everybody has had sex and it's like you can get this from… like, race doesn't matter there. Culture doesn't matter there. This is more about being in this age group.
and really on a college campus where people are “doing what it do,” if you know what I mean. But we [African-Americans] don’t usually talk about sex, let along STDs with our parents and stuff – and I think that’s a cultural thing specific to African-Americans, I think.

Culture and college: Student loans and exponential functions. The final lesson respondents specifically mentioned was the lesson on student loans and how they clearly directed and geared towards students located on a college campus. Students also included their location (on a college campus) and age (college-aged students) contributed to their culture and what the lessons had to say about these topics, as well.

Matthew: The student loan one is probably my favorite because a lot of people do have student loans for school. I’m actually in the process of trying to — I’m a military child, so my dad is trying to get a GI bill, but as of right now, I’m not going to school for free, so he’s trying to get that so I can avoid getting too many student loans.

Lindsey: I like the [exponential] equations and stuff when we did the loans. Like, we can actually use that because we have all these loans, well some of us do and I like that I can actually calculate it myself if I needed to. This showed me how math correlates to your student loans and stuff like that. Like it’s just all helpful for you to know.

Being able to connect what they were doing in class was extremely helpful for these students because they got to see the connections. Lindsey summed up this sentiment that other also touched on when she was asked if she thought other mathematics classes should be taught using lessons like these. She stated:
Lindsey: Yeah because not only does it get you more interested, it actually shows you like this is real. This is real stuff that happens! Like with the cuffing season, student loans – like this is real data! I feel we should have more real-world math. More math that is real to us because when it's not people be like “I'm never going to use math. it's useless.” But when you put it in to stuff like this then they're like “oh! So, like we really do use math like this!” We can see that there is a real use for it.

Relevant and timely. Students also spoke about how they thought this course was relevant to them in today’s time. As Pamela puts it, “all of these lessons, they’re relevant today, to us, to us Black students as of right now.” This and other comments also speak on how these culturally relevant lessons embodied the word “relevant” in that they were delivered at the right time and to the correct audience of people.

Ahshante: They were all very good topics [the lessons done in class], being a freshman coming into college; but I think my most favorite one will be the STD one because it was taught right around homecoming and everybody was just wow. In class it had everybody shook because, I mean, it spoke facts. And it was around this time where us coming in to college we really didn't get to talk about protection and stuff. But we did go in depth on how many kids actually get sexually transmitted diseases as freshmen or in college general so that was a good one.

Tiffany: Yes [the way these lessons were taught was helpful to me]. I got to know about incarceration. Just in my community, alone and how right now, people we are going through a time where we need to know how many
people is affected by it. Loans, student loans a lot of people go through that. So, I feel like a lot of these were topics were good topics to know about at this moment. Like it wasn't something to old or something for the distant future, it was right on here.

Students appreciated the timeliness of these lessons. Although not as intentional as Ahshante thought in relation to homecoming week lesson was; this helped aid in creating the other argumentation students stated above.

**Pedagogically different.** To conclude this section on cultural relevant pedagogy with regards to what was seen during interviews in relation to students’ cultural competence, several of the student made comments discussing how they thought this course was different than other mathematics classes they had been a part of before. Although discussed in earlier results sections about the mathematics pedagogy (see Quantitative Results on Research Question One: Academic Achievement), I believe it is important to revisit the concept, if only briefly because students also revisited this specific aspect in relation to cultural competence. Students’ comments in this theme made them feel as if there were not in a “class”, so to speak, rather something else.

**Jamie:** I really liked the lessons where you tried to compare the math we were doing with the real worth. Like, whenever we had an exponential function you compared it to real life situations. So, we can be able to understand it without doing word problems.

**Ahshante:** The lessons were my favorite part of this class. I really think that that was really my favorite part. I liked the lessons because I actually got to connect my life with math. So, it was more fun than [a typical] class.
At face-value, it seems as if these two students simply liked the lessons that comprised some of the lessons in course. Looking a little deeper, we see that these students had interesting views about the days of class in which these lessons were implemented. Jamie states that she was able to understand exponential functions by not having to do “word problems.” This was true in a sense, that they were not traditional word problems, but many words were involved. Similarly, Ahshante liked these lessons because “they were more fun than class,” when in fact, we did these lessons in class, taking about the same amount of time – sometimes going over on time. These comments speak to the fact that students were able to see this was different than what and how they previously conceptualized what a mathematics classroom is and should looks like. These lessons helped challenge those notions. They, and the other interview participants, were actively engaged in the non-traditional lessons, and subsequently, they though these lessons were more “fun” than a normal class and they appreciated the fact they did not have to do traditional mathematics “word problems.”

This section recounts how students responded in the interviews with relation to culture and their overall cultural competence. I began this section with a definition of culture proposed by Marshall (2002). This was followed with an analysis of how students thought about culture and what makes up their cultural identities. These aligned exceptionally well with what Marshall (2002) stated about the construct. These same sentiments fed into the reasons why these students decided to attend an HBCU to begin with, which subsequently led into why they ultimately enjoyed the culturally relevant pedagogy courses they had experienced in this College Algebra course. The themes of culture constantly cycled through this investigation into the decisions these students made and how what they were experiencing helped them move throughout this course. Overall, students enjoyed being able to literally see how what and who they are is related
to mathematics. Their culture and wanting to be immersed in it is what brought them to become students in that classroom (at this HBCU) and it is what they appreciated most while taking this course.

**Qualitative Analysis for Research Question Four: Sociopolitical Consciousness**

The qualitative data presented in this section will address the following research question related to sociopolitical consciousness: *How are college algebra students able to critique discourses of power using mathematics as a tool?* When pedagogy has a goal of building students’ sociopolitical consciousness, it is charged with equipping students with the knowledge to view social and/or political actions that are happening in their local communities, nationally, and also globally through a critical lens (Ladson-Billings, 1995b, p. 476). The experiences as reflected by students in this course centered around culturally relevant pedagogy revolve around themes related to: recognizing (that a problem exists), caring, critiquing, and acting (Table 29). These themes were observed in both parts of the interview; part one: questions about the course and part two: questions surrounding scenarios involving a topic/issue and the use of mathematics to help explain that scenario. Both sections are presented below.

*Table 29*

**Theory-Driven and Data-Driven Codes for Research Question Four (Interview Part One)**

<table>
<thead>
<tr>
<th>Theory Driven Codes</th>
<th>Data-Driven Codes/Themes</th>
<th>Subthemes</th>
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<tbody>
<tr>
<td><strong>Sociopolitical Consciousness (Interview Part One: The Course)</strong></td>
<td>Definition: Using issues that are most salient to the students (local, national, &amp; global). Students being able to recognize, understand, and critique current and social inequalities.</td>
<td></td>
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<tr>
<td><strong>Power through Knowledge</strong></td>
<td>Recognizing</td>
<td></td>
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</tbody>
</table>
| **Empowerment through Sociopolitical Contexts** | Critiquing | 1. Incarceration  
2. Education/College Loan Providers  
3. Health |
| **Social Justice Pedagogy in Action** | Acting |  |
Interview Part One: Questions about the Course

**Recognizing.** Several of the interviewed students expressed a feeling of shock when they were asked what they thought about the lessons. The lesson that really shocked the students with some of the raw facts and figures was the lesson on incarceration and linear functions. Tiffany said “the incarceration one is like… wow! Is that many people in jail!? Like, Black people at that! It’s very informational, all that. I didn’t know that before.”

Connecting what we had learned in this class with other things, Matthew had the following things to say about the topics in the course:

**Matthew:** Definitely with the changing populations in race in America and then the incarceration [were lessons that addressed my culture in this class]. Today, a lot of people see African-American, you automatically think bad sometimes. We talked about in these lessons, well… people made comments about how they always going to jail and stuff; drugs, you see a lot of people getting killed, police brutality, and stuff like that. I think we’re already at a disadvantage, so for us to fix that, it would take us all to come together as one and everything. But as to what was talked about in the class, I do believe the Black racial population and incarceration were very important things that are important today for us.

Matthew acknowledges that some of the topics that were discussed in class involved issues that are salient to him and his cultural (African-American) community. Ahshante also agreed with this sentiment when she was responding to the question of how discussing these topics in a mathematics class made her feel by stating:
Ahshante: Well we basically grown, so it's not like it was too much because it's something that needed to be talked about and still needs to be talked about and pushed for. If you don't talk about it… you don't want to make a mistake or you want to be aware. You want to be cautious. So, I think all of them was good. Like it is not just about one thing. It's about everything. All the topics should come with this education, and school. That's what we are now. We need to learn about this stuff and a class seems like a good place for it – at least the way we did it, mixed in with the math.

Pamela takes this idea a step further when she comments on how the math that was learned was also useful too.

Pamela: In a way I say [the way this course was taught] it did change my mind about math. It’s because how I now think math it is. It’s more important that you think it is. Its more than “just math” sometimes and it goes a lot deeper into things that are going on in the world today. These lessons showed me that. A lot of people normally say: “I don’t need this after school” but it showed me that you really do. Math is one of those subjects that you really need after school especially if you’re trying to understand what’s really happening.

Discussing these topics for these students was something they felt was needed because these topics reflected what was currently going on in society and thus, were affecting their day-to-day lives. Not only their lives, but also people who looked like them and were a part of their same culture.
Caring. When learning about these sociopolitical topics throughout this course, students often expressed varying degrees of empathy for the populations of people that were being discussed. After the course was over, and throughout the lessons themselves, students thought heavily about the issues that were being discussed with the mathematics.

Jamie: [These lessons] made people in the class think not just about like what the equations was or whatever math we were doing but how it could affect us. So, they basically depict what can happen in the future if this continue to happen – happen to us and other people.

The comments from Tiffany echo similar sentiments with regards to these are real issues happening to real people.

Tiffany: [These lessons] actually made me realize like this is really happening. Like, this is actually life! It might not be affecting me personally, but a lot of people who look like me and that is just sad, honestly. It really got me thinking about how to prevent things like that from happening so often?

Feelings of wanting to prevent and/or help alleviate some of the issues that were talked about (specifically incarceration and banking choices by poor people) came up in several of the interviews. Take Lindsey’s response when she was asked about the role culture should play within a mathematics course. She stated the following thoughts deeply rooted in her background and her feelings about incarceration and how it has played a role in her life.

Lindsey: Like it was always something we were talking about and it got me thinking outside of math. So, like when I'm doing math, I'm like thinking of these real-world situations – like this is actually happening, you know. How can I help prevent that? Like, think about the incarceration [lesson]. I
knew a lot of people that have gotten locked up for no reason… well, to me for no reason. I know a lot of people that do dirty things and don’t get locked up, and I feel like it’s just because of the color of their skin. Yeah, I take the incarceration thing a little far. I just feel really bad for them because race has a lot more to do with them being locked up than their actually petty crime.

The empathy that Lindsey exhibited was for people of color, who themselves, were in the incarceration system. She, and others interviewed, really connected with people in the situations that were brought up during these class discussions as a result of the culturally relevant pedagogy lessons. Kanisha took a different approach with the empathy she was exhibiting. It wasn’t directed towards a particular group of people, like some of the other statements were above. She wanted people, specifically White-Americans, to show empathy towards African-Americans. She believes that culturally relevant pedagogy performed at a predominantly White institution could be a potential conduit to perform such a task to illicit such a response.

**Kanisha:** A lot of times, even in the predominantly White schools, a lot of times they show; rather, they wouldn't show about statistics about the White becoming smaller in number [exponential lesson about rising population of minorities in America]. They wouldn't show this. But I think like in their life in general, a lot of White kids don't get the information that they need, so they're only stuck with what they know, but this is reality, you know. This is OUR reality; the incarceration is reality. I mean I think it would give them a better outlook on us as Black people too. There could actually be something wrong with a system that is incarcerating us more
often than them, even though they more than outnumber is in overall population. This reality to know that it's not just minority kids it's your college too suffering student loans and struggling to repay them. Student loans is an everybody-issue.

**Critiquing.** In the final sections of this chapter, the final part of the student interviews will be explored which was geared at having students use mathematics to critique various situations. Before even arriving at that part of the interview, some student had already begun to critique society through the various contexts of the culturally relevant pedagogy lessons. I want to highlight two students, in particular, who had some critical thoughts related to incarceration, education/college loan providers, and healthcare before being prompted to do so.

**Incarceration.** Perhaps the most things throughout all the interviews was about the culturally relevant pedagogy lesson centered around incarceration. Perhaps, it was because this was the first lesson that was presented to the students, or it is an issue that students are invested in. At any rate, Kanisha had the following to say as it relates to incarceration:

**Kanisha:** Incarceration um, I thought that that lesson was helpful too. As Black adults and young adults, you know, we need to know certain things especially about incarceration and its role in life… like this is our life! Pretty much. That's what they’re doing is putting it as a part of our life. It’s all racism. Incarceration is part of my culture too, but not my culture per se, like not directly towards me, but it is a part of Black culture. Like I said it's how they see us. It's our life. It's worse the prisons are filled with us because of the crime rate or the so-called crime rate that they put us in. Yeah, that is definitely a part of our culture. Sad but true. Show them the
graphs and the numbers and they'll rethink somethings – probably not though.

Using that lesson as a launching pad for her thoughts, Kanisha began to think about what we did in class and wondered if looking at the statistics we looked at in class would lead to a change in the system of incarceration and crime rates and arrests made by law enforcement.

**Education/College loan providers.** The concept of knowledge, how it is obtained, and who is responsible was something a few students commented on. Jamie believed that no matter what anyone is supposed to do (your parents, public education/K-12, or in college courses), to acquire knowledge related to salient topics, such as the ones discussed in the course, “you have to teach yourself, because you can’t rely on nobody to teach you.” Kanisha agreed somewhat with this sentiment; however, when it came to the issue of student loans, she placed that blame on a variety of stakeholders involved, including: the student, parents, financial aid offers and offices, and colleges, themselves.

**Kanisha:** As far as like the student loans, I've never taken out a student loan fortunately. I didn't have to as a military pays for my school but just to know about this information is important. It's, you know, it's really important and informative for these kids – let me stop calling them kids… young adults – to know the importance. You know, a lot of people say “okay imma take out a loan,” but a lot of them take out a loan just to get the extra cash, right. But then it's like the amount of money that you're taking out by the end of the day, you know, how much you're gonna pay back is a lot-LOT more. So, like to me it's not worth it, you know? No one is telling these kids that. These college and financial aid offices should be
telling them. Here's the math we learned in class – have students physically type in the equations themselves before they accept the loans, right in their offices, and see if they think twice about getting so much! And colleges are too expensive and getting more and more expensive every year. That's probably the bigger issue.

**Health.** The topic of health really got Jamie talking and deeply reflecting on her own personal home life with her family and issues dealing with health and insurance. She begins her statements discussing the sexually transmitted disease contraction lesson (in relationships to quadratic equations) and transitions this discussion into one about the overall well-being and health of African-Americans. This then evolves again into a discussion about what she believes to be the true heart of the matter: expensive health insurance premiums, which preempts her to proposing change.

**Jamie:** I guess the STD patterns. African-Americans have a hard time telling their doctors that they have something that they can't get rid of. So that's the same thing with just regular illnesses in general like diabetes high cholesterol. Because we are, we're not too known about going to the hospital and looking after our health because that's the main priority. It could be a number of things that could happen to your body. But we as African-Americans need to keep ourselves in check whenever it comes to these types of things. A lot of times, we weren't taught these things. This leads to an even bigger issue of what I would really want to talk about is good health care for just for all different types of races. It's too expensive and a lot of people can't afford it. If we got data on these types of diseases
and compared when people actually come in to get help based on whether they had insurance or not, and plotted it on graphs and showed them the equations, I would hope that would change some things.

These discussions held with Jamie and Kanisha were extremely enlightening in what students (more than likely) were already passionate about, or had previously thought about these issues, and how they connected what was done in these classes on these “experimental” lesson days. These connections will be further explored in the Qualitative Analysis for Research Question Four: Sociopolitical Consciousness (Interview Part Two) section at the end of this chapter.

**Acting.** Discussions from reflecting upon the mathematics that students learned led them to really hone in on the issues (the context) and how it was affecting them and their thoughts. These reflections were often quite deep and students had been pondering and constantly thinking about these sociopolitical contexts since speaking about them during the specific lesson classroom period.

**Lindsey:** Incarceration. A lot of my family has been locked up and I can I see the difference. Like something that the people that raised me [African-Americans] would do that would get them locked up, but something that if my mom's side of the family [Caucasian] did it probably would even get a slap on the wrist. Like it just, I like the fact that I can see it from both sides and perspectives, but it's just messed up and I wish I could just do something about it.
Similar to this sentiment of “wanting to do something” about the reality of the situation, Kanisha echoes this feeling as well. She also wants other African-American students to feel the same way because of the reality of this pervasive issue in society.

**Kanisha:** The only thing that really made me feel some type of way is, I believe, would have been that incarceration one. Just to know like this is real. Like just introducing it to the Black students because it deals with Black people. It makes them, or it should make them, even look like for their future like “I don't want to be a statistic. I don't want this to be me,” you know. The total prison population went down a little in that time period, but we're still the majority. But it's like: okay, as a Black student what can I do? What can I do so I'm not that statistic? What can I do to help my community so we can bring down the number? So, I thought it was very helpful. But as far as like feeling the type of way, it's just a feeling of what can we do?

This idea about finding the next steps or “taking action” is something that was explored in the final part of the interviews with students. They were asked to reflect upon several situations and indicate how they could potentially use mathematics to explore the situation, if they thought it could be explored with mathematics, what mathematics was being used, and how it was being used.

**Qualitative Analysis for Research Question Four: Sociopolitical Consciousness (Interview Part Two)**

In this final section of qualitative data results, I will present the findings of the second portion of the student interviews, where students were given one or three scenarios (two
sociopolitical, one culturally relevant) where they were asked first, their opinion about the topic, then second, if mathematics could be used to help either explain the situation or bolster their stance on the topic being asked about. The topics asked included: whether the federal minimum wage should be increased from $7.25 to $15, party decisions, and the killing of unarmed Black-Americans by police officers. The results will be presented below and divided by topic (Table 30).

Table 30

<table>
<thead>
<tr>
<th>Theory Driven Codes</th>
<th>Data-Driven Codes/Themes</th>
<th>Subthemes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sociopolitical Consciousness (Interview Part Two: The Mathematics)</strong></td>
<td><strong>Definition:</strong> Using issues that are most salient to the students (local, national, &amp; global). Students being able to recognize, understand, and critique current and social inequalities.</td>
<td>1. <strong>Recognizing:</strong> Justifying a problem actually exists 2. <strong>Caring:</strong> Comparing two different situations 3. <strong>Critiquing:</strong> Explaining how a change would affect a larger system</td>
</tr>
<tr>
<td><strong>Minimum Wage</strong></td>
<td></td>
<td>1. <strong>Recognizing:</strong> Modeling Fun 2. <strong>Recognizing:</strong> Modeling Profit</td>
</tr>
<tr>
<td><strong>Party Planning</strong></td>
<td></td>
<td>1. <strong>Recognizing:</strong> Modeling Fun 2. <strong>Recognizing:</strong> Modeling Profit</td>
</tr>
<tr>
<td><strong>Deaths of Unarmed Black-Americans by Police</strong></td>
<td></td>
<td>1. <strong>Critiquing:</strong> Describing the severity of the situation 2. <strong>Acting:</strong> Projecting and exploring trends</td>
</tr>
</tbody>
</table>

The analysis in this section will not primarily look at the specific responses that students gave regarding their opinions on the topics or the specific mathematics that students were using; rather, the analysis is focused on how students were using the mathematics that they were employing during their commentary. The analysis yielded themes consistent with the themes presented above. They center around recognizing (and/or analyzing/justifying an issue), caring, acting, and critiquing. It is also important to note that students were not asked to do any
mathematical calculations during this portion of the interview. They were asked what mathematics could be used and to explain what they would do or use if they had access to any information, they thought was necessary to fully explain their thinking and reasoning.

**Minimum wage.** The first topic students were asked to respond to dealt with the sociopolitical topic surrounding minimum wage. Students were prompted with the following statement: “There are some jobs in the university, especially those for students, where some people are making minimum wage at $7.25 per hour. People have been talking about raising the minimum wage to either $10 per hour or even $15 per hour.” After the prompt, students were asked if they believed that the minimum wage should be increased and why they thought this way, followed by a second question in which they were asked: “in order to support their argument and position, in what ways could mathematics be used, if at all.” Students used mathematics in three main ways to describe their thoughts about minimum wage: to justify that a problem actually exists, to compare and contrast situations between groups of people, and to explain how a change in wages affects an entire system.

**Recognizing: Justifying a problem actually exists.** The first theme that showed up during analysis was one where students used mathematics to justify that a problem actually existed by describing and modeling a person’s situation. Several students described how they would use iterative calculations, linear equations, and ratios in order to show by not increasing minimum wage, people would not be meeting their basic needs. Asia-La’Rae believed that minimum wage should be increased because she felt as an 18-year-old single, non-parent, college student, she feels it is impossible to live off making $7.25 with even the few bills she has to pay every month. She found it highly improbable that people with families and children could
manage to make that living situation work. When asked how she could use math to help explain her reasoning behind her opinions, she had the following to say about the situation:

**Asia-La’Rae:** I would say, simple math, such as groceries, bills, car, gas, and see how for a person that would be for person making seven – whatever the minimum wage is, and getting paid two paychecks a month and see how that works. The basic needs of life, simple math, times their minimum wage and getting paid every other week and see what that cost and what that equals up to in the end to see the cost of actual basic needs of living. Not anything extra, nothing out of the ordinary, but the basic needs – if it's just that one person and child, two, three, whatever. Just do the basic math.

Asia-La’Rae is describing calculating a living wage dependent upon the number of children a person has and comparing someone’s current finances over a month and looking at that to show that a person making minimum wage cannot make enough money to meet the basic needs.

Similarly, Kanisha, who also agreed that the minimum wage should also be increased to $15 due to an argument that as the cost of living keeps going up so should the minimum wage, also had similar comments along this line of thinking.

**Kanisha:** Look at your expenses. Your debt-to-income ratio. You know you have your income, then you have your expenses, and then you know you your monthly expenses thing you add it all together and you subtract and you got a negative there's a problem! There’s a problem! How are we living, how are we eating? You know, so then you know do you take in consideration like it's a family of two or it's if I'm by myself, okay fine
whatever, but still one can live… I wouldn't even let my son work for $7.25 an hour, I'm sorry.

Both these students used mathematics in order to justify that a problem actually existed, and proposed that raising the minimum wage would help alleviate that problem (although Asia-La’Rae would love to see that number be even higher). While doing the culturally relevant pedagogy lessons in this experimental section of the course, students had to work with data that they used in order to help explain the existence of a problem just as these students were doing with this sociopolitical topic of setting a minimum wage.

**Caring: Comparing two different situations.** Students also gave responses using mathematics that allowed them to compare groups of people based on differing situations they found themselves in: making minimum wage and making above minimum wage. For this use of mathematics, students proposed using equations, such as profit functions in order to show comparisons.

Tiffany believed that the minimum wage should be increased because college students’ limited options on campus to actually work beyond the normal hours of operation on Bernard St. Stephen’s campus and due to the rising costs in tuition and fees. She felt that if students were trying to be responsible and contribute to their own educational expense, the only way for that to happen is for them to be able to make more money in the time that they are able to. She stated the following as her explanation of her use of mathematics in helping her craft an argument for her supposition.

**Tiffany:** Yeah. So, definitely the information from the Internet and like make a graph of like the people that are making minimum wage, like by the end of the year how much are they doing. And they also do like their living
expenses their car expenses like every bill and stuff that they had to pay. And then the people that's making above minimum wage how much they're also making their expenses and everything like in the same situation like saying living expenses cost and everything is the difference in making $7.25 and making above $7.25.

She believed that showing the difference in the yearly net profit for people making minimum wage and those making above minimum wage would itself justify increasing the minimum wage from $7.25 to $15 (or “somewhere around that number”).

Pamela also used a similar argument; however, her belief was that the minimum wage should not be increased because, as she (and one other student) puts it: “a McDonald’s worker should not get paid the same as someone with a college degree.” She proposes showing this difference in yearly net profit or savings to high school students as a warning to show them that getting a college degree would afford you a lifestyle that you would probably want to live.

Looking at profit functions was a key part of the experimental lesson based on health and flu shot maker/distributor companies. These students particularly used the principles of that lesson and their knowledge of how “life works” to formulate an argument – to different audiences – of the projected outcome of different groups of people based off of hourly income.

**Critiquing: Explaining how a change would affect a larger system.** Finally, students crafted arguments for and against the raising minimum wage using mathematics to justify their responses that revolved around explaining how such a large increase in minimum wage would affect not only the people receiving said increase, but also everyone else working within this environment/system. Generally, the students that used this argumentation disagreed with the majority of students in that increasing minimum wage from $7.25 to $15 should be done.
Both Matthew and Lindsey used mathematical principles of optimization through inequalities and graphs of these functions and systems of equations to demonstrate and explain their reasoning. Matthew believed that in order to accommodate such an increase in the minimum wage, schools and (other work places) would have to have to lay off people because they would not be financially able to support giving raises to a vast number of people. He stated the following in support of his position on the topic:

Matthew: In my opinion, no [the minimum wage should not be increased to $10 or $15], because if you do that, then, I don’t know how much the school has to give out – but from what I would think, I would say no because if you do that, you wouldn’t be able to hire a lot of people. Some people’s hours may get cut short. Maybe that’s when it could be shown using a graph; it'll probably be quadratic-looking because the higher the salary, the less people could be hired. Also, look at If you do raise it, how much money is left for the school to use for different things for stuff that we need, like athletics and stuff like that. You would see a lot of the important stuff is going down and then you just put two and two together and then you’ll see that you need to keep minimum wage what it is.

Lindsey (much like Pamela) stated that people working at fast food restaurants should not make more money that Emergency Medical Technicians (EMTs), who she felt/knew that some of them did not even make between $10 and $15 per hour. She didn’t go as far as to say these people should not get raises at all, but believed it should not be higher than $10 per hour. Her argumentation for this position was:
Lindsey: You would have to see how much you have to distribute out to the people that you're paying and raise it out to a certain extent to where everyone gets paid the same. So, like where you're not breaking the budget like going over like the set budget you have to pay everyone. So you would have to incorporate how many employees you have, how many hours they work, and then figure out okay if we pay them eight dollars an hour we pay everyone on campus as jobs like this eight dollars an hour, and they work this amount we have enough money to pay all of them instead of like oh we're just gonna give you ten dollars an hour and then not have enough money to pay everybody

Similar to the previous theme of comparing situations using mathematics, students who used this theme of explaining the ramifications of such an increase in minimum wage used the reasoning we used during the health lesson. Students used the mathematics learned in those lessons and combined it with the discussions that were had throughout that lesson to help them craft these arguments to support their position on minimum wage.

Party planning. The second topic students were asked to respond to dealt with a topic that was around a topic that was less sociopolitical in nature, but related to the culture of living on a college campus, and one that I thought students would say that mathematics was not involved at all. This topic was surrounding the decisions people make to attend or not to attend a party or social gathering at or around a college campus. Students were prompted with the following statement: “I remember the class after Halloween, people went to a lot of different parties the night before. So, in deciding which party to go to is there mathematics involved in that?” Responses given by students were interesting, in that no one said “no,” rather, they
explained what application of mathematics they actually use or what they would use in such situations. Responses revolved around the themes of modeling fun and profit revenues.

**Recognizing: Modeling fun.** Most students gave responses that in some way touched this idea that the reason for them wanting to go to a party to begin with involved them first, and foremost, enjoying themselves and having a good time mingling with their peers. Lindsey embodied the responses from most students, except she hit on every point that was discussed in all others’ responses. She was extremely keen on this question, due to her high involvement and participation in the culturally relevant pedagogy lesson delivered on the class period after Halloween (as mentioned in the prompt). She stated the following in response to this question:

**Lindsey:** There are many equations involved. The first involves the population of the part and the amount of space available. If there's way too many people, it’s going to get shut down. I went to a party Halloween night and we had to choose between the Q party and a block party. The Q party was down the road, and we knew everyone was going to go to the Q party, because it’s a Q party… who’s not going to go? It’s a Q party. So, we were thinking there's gonna be a lot of people there just because it is the Q’s. So, everyone's gonna be there, so you gotta think about this space cuz it was at a house so the space around the house. The space around the house and all the people inside the house and then eventually the party was gonna get shut down cuz every Q-party gets shut down. So, the chance of it getting shut down is equal to the set amount of space minus the number of people entering the party every hour. So, what we thought about was okay so the house is only so big, the yard is only so big and all the people
that's going. If it does get shut down, is it gonna be too crowded run? I know that's horrible to think but its real. Another equation is the type of fun can we have. Like we already knew there's gonna be smoking, underage drinking – it's Halloween and homecoming. It’s like, are we gonna be able to get out in time? Are we gonna get caught up? That’s another equation. How fast we can fun if something crazy pop off, like a fight or gun shots – and remember this is depending on the first equation with space and people. This may be an exponential function because we’d probably be able to run fast at first, then slow up as we got tired. 

[Laughter]. Um, ok… then we got to think about the block party which we had to think about the time walking there which was 25 minutes which was another factor. So, it was 25 minutes to walk there, and not that many people know about it, so hopefully it's gonna be laid back you know we can just chill, listen to music, do what we do. So, we decided to go to the block party cuz even though it was a farther distance we figured since it was a farther distance everyone's gonna be a little bit too messed up to walk that far so we decided to go to that one for the factors of less people times a farther distance. The block party seems quadratic with all the two factors multiplying that gave us a better answer in the long run since we didn’t have to think about the other stuff that a Q-party brings with it.

This quote was extracted from Lindsey after she originally did not know how to respond – which was frequent for her. She would often have long pauses of silence, followed by blocks of fruitful statements after simply needing a rephrasing of the question and some time to think.
Lindsey brought together many of the experimental lessons that was discussed throughout the course, including linear functions, quadratic functions, and exponential functions. To say it like Pamela phrased it: Lindsey thought about this topic using equations, “but typically most people do this without thinking about the specific math or equations. People just make decisions without thinking its math, but it can be if you want it to be. Almost anything can be!”

**Recognizing: Modeling profit.** Two of the respondents, Pamela and Jamie, thought through this scenario as if they were the ones throwing the actual party and not going to one (opposite of how I had environed the direction of the scenario). Using the quadratic profit-revenue function discussed in class, they explained how depending on several factors, that would determine the constraints of a certain party they would try to throw in order for it to be successful.

**Jamie:** Yeah [party planning involves math] because it depends like how many tickets you sell. So, like say if there is one party everybody talking about: “oh, we gonna go to this, everybody is going to go to this,” but if you plan the party at the last minute not a lot of people are going to show up because you do it first you get exposure so you didn't get people to expose the party. But after that town that's when you start raising the prices. So, like if you paid a pay five dollars you have to pay probably $10 by 10 or 11 o’clock. Then the price will bound back up more around twelve o’clock. You can only raise the price so much to make sure you get the most number of people possible, depending on the size of the house the party is in.
This discussion focused on making money from throwing a party. With variables about the total number of tickets, space, and advertising, Jamie gave a thoughtful response on how she would use mathematics to address this situation. Other students making responses for this situation of thrown a party were not as loquacious the quotes used in this theme; however, responses from this theme did use mathematics and describe its use using mathematics that was experienced in the culturally relevant pedagogy experimental lessons which helped them make more compelling arguments to support the points they were trying to make.

**Deaths of unarmed Black-Americans by police.** The final topic discussed at the end of the interview was focused on issues surrounding the killing of unarmed Black-Americans by police officers in the United States. Students were prompted with the following statement: “As I am sure you are familiar with news stories about unarmed Black-Americans being killed by police officers in America, what are your thoughts towards this?” After students gave their opinions on the topic at hand, they were then asked, “Who, if anyone, has the power to affect change or impact such shootings?” The final question in which the analysis of this section was related to was: “How, if possible, can you use mathematics to address this situation and help you enhance your arguments?” Responses on these final questions revolved around major themes as to how students were using the mathematics: to show the severity of the problem (using statistics) and then projecting what would happen if the pattern continued.

**Critiquing: Describing the severity of the situation.** The way that students began using mathematics to help their arguments on why the shooting and subsequent killings of unarmed Black-Americans was problematic (which everyone agreed was a major issue that makes them feel many different emotions), was to show how this was an issue. All students began down this path of discussion and described how they needed to gather the data and statistics that has been
collected. Perhaps, none more passionate than Lindsey who, remember, is half-White and half-Black and has been personally affected by this situation. She had the following to say:

**Lindsey:** I feel like, using statistics and showing like stuff has happened in the past and like the ratio Black men being – I’m trying to remember because I just did a project on this. Ummm… I think Black men are ten or fifteen times more likely to be shot and killed by an officer than White men. They’re (I think) one in sixteen are more likely to be abused by officers. So, I think just using statistics and showing them the numbers and that, this is real. Even though, you know, “one of your homeboys just got shot,” yeah. It’s more than just your homeboy. There’s people out here everywhere getting shot and killed by police for no reason, so I feel like showing the statistics to both sides [Black people and police officers] I feel that it would help both sides.

She then goes on to discuss her personal feelings and emotions and how practical steps could be taken with this information that involves both African-Americans and police officers. Focusing on the statistics is the way Lindsey saw how mathematics could be used. Others too began with this usage of the subject and took it a step further by explaining how if the problem persist, then they could potentially project these effects using mathematical representations of the data.

**Acting: Projecting and exploring trends.** Several of the interview participants commented on how they would use the statistics gathered to display the data visually in hopes to compel change.
Pamela: Oooh… I don’t know. Yeah, you use statistics. You throw the statistics at them. In the year 2000, this was a number, in the year 2005, it’s this number. And then you can combine them, and take them apart and pull different aspects and see how the numbers change. I know you could then make an equation, and you could definitely take a graph and have like the shootings of the year and then pull out, this is how many students, and this is how many males were unjustly killed…. Looking at percentages and ratios. You then take that graph and look at the next few years to show what would happen if this continued.

Matthew: Umm… I would make a graph showing the past few years. First, I would put how many people who are like, do an estimate of how many Black people died within the last, say, 10 years, and then continue that equation to project in the future. I would show this to people, police, to show that if they don't change, these numbers would probably continue to increase. It'll probably be linear because I feel the number goes up more and more each year -- not a lot, like exponents, but consistently.

Using principles explored in class, students were able to verbally describe what they wanted to use and how to use it, which it comes to mathematical exploration. For these few students, the predictive modeling was important and this is what was felt would be the fundamental reason for catalyzing change – to stop the continued killing of unarmed Black men by police officers.

Students really mirrored their arguments in the same way that the culturally relevant pedagogy lesson on incarceration was presented and explored: by first exploring data that had
been collected on the issue, then by using linear equations and functions to explain what is currently happening with this data set, then extrapolating responsibly and relatively close in the future to show that if all other factors held constant, then they could know what to expect. Perhaps the most sociopolitical topic discussed during the experimental phase of the course, this topic was one that students stated they enjoyed how it really allowed them to see how mathematics could be useful and helpful in “the real-world” (see prior sections on Cultural Competence).

**Chapter Summary**

This research question concerning a qualitative look on academic achievement in this course centered around culturally relevant pedagogy revealed several themes including the reshaping of curriculum (the effects that this “different” instruction), the role of the instructor in this reshaping, and the subsequent mathematical identities that emerged from this course. Students overall enjoyed this course and the interactions it afforded. Students were able to see connections and become more involved in a course that was not as student-focused and student-centered as this one. When the materials that students were engaging with utilized pedagogy that was in line with their cultures, a deeper understanding of mathematical concepts was had by students. The instructor played a huge role in the perceived success for students due to the innovative nature of this course. As students constantly mentioned, not every teacher is equipped for such interactions with this style and type of pedagogy. Students viewed this instruction in various ways depending on how they came into the course and how they viewed the subject of mathematics. Through the interviews, all students stated they appreciated the cultural aspects of the course since they were able to see the connections with what they were learning and how it...
related to their own lives. This, subsequently, held their interest and their confidence in their mathematical abilities increased as a result.

With regards to cultural competence, an exploration of what students’ definitions of the term “culture” led to the reasons why they wanted to attend Bernard St. Stephen University, a public historically Black University. Students appreciated their cultural aspects being reflected within a college algebra mathematics course. They were able to interact with mathematics in ways that lasted with them even after the course was over. Students were able to use the critical thinking and examination skills that were practiced and utilized in these exploratory lessons in the contexts of other sociopolitical and cultural situations that had not been explored in the course. Student were able to use mathematics in a variety of ways and with a variety of emotions to advocate for a certain position. The complex nature of these positions and the mathematics used are advantageous for students who, most will not take another mathematics course; however, they will be able to utilize these skills in their various fields of study and as a part of becoming productive members of society.
CHAPTER 6: INTEGRATION OF QUANTITATIVE AND QUALITATIVE FINDINGS

This study utilized an embedded QUAN(qual) quasi-experimental mixed methods design, where the qualitative data was collected within a traditionally quantitative design in order to further elaborate and expound on those findings. This dissertation used several quantitative measures including students’ grades and assessments, the PCI, the VAMS, in order to ascertain how participation in a course that utilized culturally relevant pedagogy lessons affected outcomes related to academic achievement. These measures helped to answer research questions one and two. Next, the YSRM was also administered and analyzed to see what effect this culturally relevant course would have on students’ cultural competence and how they view the interplay of race and mathematics in an attempt to answer research question three. Next, this study analyzed interviews with eight of the students who participated in the experimental section to gain an in-depth understanding of how students experienced some of the concepts from culturally relevant pedagogy (academic achievement and cultural competence) to answer research questions two and three. In this final section of data analysis, I re-examine the research questions relating to academic achievement and cultural competence, both of which utilized quantitative and qualitative data analysis. Within each section, I will remind the reader of the research questions I addressed, followed by a summary of the most relevant results. I will then integrate the quantitative and qualitative results from academic achievement and cultural competence (see Table 31) to show how the qualitative data was used to support (or refute) the main quantitative findings.
### Table 31

*Summary of Mixed Method Analysis*

<table>
<thead>
<tr>
<th>CRP Tenet*</th>
<th>Quantitative Data/Analysis</th>
<th>Qualitative Data/Analysis</th>
</tr>
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<tbody>
<tr>
<td><strong>Academic Achievement</strong></td>
<td>Students in experimental course showed statistically significant gain from pre- to post-survey assessments (grades and PCI). These results also showed medium to large effect sizes for these students.</td>
<td>Data supports these statistical findings. Students reported how they liked the stricture of the course (interview data with students from experimental class).</td>
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<tr>
<td></td>
<td>Students’ views about mathematics shifted towards more “expert”-like views from more naïve views about mathematics as shown on the VAMS.</td>
<td>Data helps explain how the intervention course allowed students to see the utility and usefulness of mathematics (interview data with students from experimental class).</td>
</tr>
<tr>
<td><strong>Cultural Competence</strong></td>
<td>Shifts occurred on several of the responses of the YSRM concerning students’ thoughts about the use of mathematics in their daily lives.</td>
<td>Data supports this finding. Students reported how the CRP lessons allowed them to see mathematics and its applicability in their daily lives (interview data with students from experimental class).</td>
</tr>
<tr>
<td></td>
<td>Results from Fisher’s exact test for independence showed that STEM majors were more likely to disagree that African-American were given as many opportunities to succeed in mathematics.</td>
<td>Data helps explain this finding somewhat. One of the students gave an account of why she did not wish to pursue a STEM degree partly due to previous negative experiences in mathematics courses (interview data with students from the experimental class).</td>
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*Note. Sociopolitical Consciousness, the third tenet of CRP was not included, because it was explored solely through qualitative data sources.*
Academic Achievement

When it comes to the first tenet of academic achievement, the research questions that revolved around this concept were research questions one and two. Research question one is *What effect does culturally relevant pedagogy have on student achievement in a college algebra course offered at a historically Black university?* Research question two is *How are student views about mathematics affected in a course centered around culturally relevant pedagogy?*

**Student Achievement**

Research question one was explored using two quantitative instruments: students’ formative and summative assessments which were administered before and after the culturally relevant pedagogy lesson intervention and the Precalculus Concept Inventory (Carlson et al., 2010) which were administered near the end of the course. Results from both quantitative data collection tools show that the students in the experimental course were positively affected by their experiences in a course that utilized culturally relevant pedagogical lessons during a concentrated portion of this course. Specifically, the scores from the experimental group were shown to have a statistically significantly change from their pre-intervention unit test grades to their post-intervention unit test grades (with results showing $p < .0001$). When compared to a control group (students who did not have culturally relevant lessons, but lessons that were grounded in good mathematical teaching practices), the test statistics showed that these students were performing at similar levels on their standard course assessments before the culturally relevant pedagogy intervention, but performed statistically significantly different (in favor of the experimental group) after the intervention. Furthermore, students in the experimental group outperformed students in the control group on their final exam and overall final grades in the course. Cohen’s $d$, the standard for effect sizes, indicated that the intervention had a medium to
large effect on these outcomes of interest with the unit test grades (0.59), final exam grades (0.56), and overall course grades (0.66). Through a Pearson correlation matrix (Table 20), shifts in the pre-intervention precalculus concept inventory to post-intervention concept inventory had a positive correlation with students’ final grades.

**Views about Mathematics**

Research question two was also explored quantitatively and it centered around issues of students’ views on mathematics through using the Views About Mathematics Survey (VAMS) (Carlson, 1997; Carlson et al., 1998). Looking at how students used mathematics through this survey showed that students in the experimental group had larger gains on their post-VAMS compared to the pre-VAMS. This means students went from viewing mathematics as having less to do with algebraic manipulations in order to come to a disconnected answer to more of how “experts” in the field view it, as a tool to answer questions about the real world and a process that involves constant iterations. More specifically, students who received the culturally relevant pedagogy lessons demonstrated a shift towards expert mathematical thought on questions concerning mathematics being a subject requiring effort on the students’ as part of a perseverance process to grappling with challenging mathematics tasks, the role of technology in a mathematics classroom, and the relationship of mathematics to everyday life.

The quantitative results also showed that the VAMS offered some insights on student achievement (research question one). There was a positive correlation between the change in VAMS score (from pre-VAMS scores to post-VAMS scores) and a student’s final grade. There was a large effect size (Cohen’s $d = 0.6$) associated with this correlation as well. Holistically, students who were able to view mathematics as a subject akin to how expert mathematicians viewed it were generally students who performed better in the course. All students who received
an Expert VAMS classification were those who received A’s and B’s in the course. The students classified as transitional (either upper or lower) received A’s, B’s, or C’s, and the students classified as Naïve received the lowest grades in the course. This study found evidence that for students who were able shift their views about mathematics, they were also more likely to have higher grades \( p < .01 \). This was also seen in a study by Carlson (1999) when she studied successful graduate students of mathematics and the factors that lead them to success.

**Connecting Achievement and Views of Mathematics**

These quantitative results can be supported by qualitative data collected to examine research question two, which concerns itself with how students view mathematics throughout a course centered on culturally relevant pedagogy. From the qualitative data collected throughout this study, we see that these effect sizes and tests of statistical significance of differences can possibly be explained and supported by the interviews and the responses on the mathematics reflection journals that students filled out. These qualitative data sources speak to the course structure, itself, and how students positively reacted and related to the course. Under the first theme of “Reshaping the Curriculum,” students consistently compared the culturally relevant pedagogy lessons to their prior mathematics course experiences and they overwhelmingly agreed that this course was certainly different in a good way. Students commented (in Chapter 5) on how their previous mathematics courses lacked connections to their cultural backgrounds and how they remembered the material not being particularly relevant to their lives or the lives of others around them. By adding this to the course, students were able to “enjoy” a mathematics classroom in ways they have not done so. Ahshante was a prime example of this:
Ahshante: No. It [mathematics class] was straight work. We had fun while doing it, but this year was my first year we actually got to do stuff like this. Like, I never seen this in none of my classes, which made it so fun.

Through the contexts that this mathematics course provided, students were able to make connections with the mathematics that they were learning about to their own lives. More connections helped students be more focused in class and allowed them opportunities to participate and interact with the mathematics being learned. This can be seen with Lindsey:

Lindsey: I feel like [the context is] very relatable. I feel like anything that you can relate to you're more interested in. So, if they [instructors] can just put more culture or more any like anything into math instead of just simple equations with stuff it'll get kids more interested in it and like that's one thing I really liked about your class: I was always interested.

There is evidence that these connections and subsequent reactions with the pedagogy on cultural relevance showed in students’ grades and assessment performance and also in the course and through changes in the Precalculus Concept Inventory as well as other course assessments.

Students truly valued these experiences they were able to have in a unique mathematics classroom experience. Students state how they, along with their peers, were able to have “real” conversations that made the mathematics come alive. This allowed them to be more engaged in the mathematics and participate allowing for a rounded understanding in how the mathematics that was being learned connected with the real world. Students were able to express how they were able to see the problems on their various assessments and think back to how they participated in class to aid them in their problem solving. Even in the latter part of the interviews when students were able to explain how they would use mathematics in order to help explain
issues that would come up in their lives, students were demonstrating their abilities and willingness to not run away from the challenge of using mathematics in everyday situations. For example, Kanisha embodied this notion of being able to see mathematics in these everyday situations when she was asked if mathematics was involved in deciding which party to attend. She states:

**Kanisha:** No. Let me see, because I could be wrong. I'm trying to think okay, so you go out and only math will be like how much is this club, and how much it's gonna cost, you know are the drinks more at this place or that place, you know what I mean. So, I guess some money math. Not like, “well… there’s going to be 20% males and 80% women… so no. Lol. I guess you could think that way, depending on what your goal was. From this course and the stuff, we’ve talked about, I now believe you can put math anywhere. [Laughter]. You could really use math anywhere. I could use math when deciding how many people could fit or how much money could be made if I were selling tickets. Factoring in that space and all of that, I could come up with some equations. Quadratic for the making money and linear, probably for the number of people.

Initially, Kanisha immediately said “no”, that mathematics was not involved in such a simple scenario as this one, but without any prompting or probing for her to think more or to come up with a different answer, she began to think back to prior experiences in the course and came up with some good uses of mathematics in this everyday situation. She notes that you can insert mathematics anywhere, which is a notion which is at the heart of academic achievement – being able to use think about the long-term success of students (Ladson-Billings, 2006b).
Instilling the skill of critical thinking and representation through mathematics is a huge goal in mathematics and the general education requirement of a course like College Algebra at Bernard St. Stephen State University.

**Cultural Competence**

The second tenet of culturally relevant pedagogy is cultural competence. The research question that situated itself in this tenet was research question three: *How do students enrolled in a college algebra course at a historically Black university define and describe their culture and their experiences with lessons designed to be culturally relevant?* This research question, like research question two, was explored using quantitative and qualitative data sources.

**Race and Mathematics**

Research question two was first explored using the Youth Survey on Race and Mathematics (YSRM) (English-Clarke, 2011; English-Clarke et al., 2012). A few questions from the subset of questions under “your experiences with race and mathematics” and “attitudes about math and race” saw changes in the experimental group from the pre-YSRM to the post-YSRM. A small shift occurred for the statement that Black students are given as many opportunities to succeed in mathematics as people of other races. On this statement, 12% of respondents disagreed more on the post-survey than did on the pre-survey. From the responses, we can also see that a majority of students believed that Black people were not held back in mathematics. With a little over 50% of disagreement versus 12% of agreement, but over half of the students also believed that African-Americans are not given as many opportunities to succeed in mathematics as people of other races.

The largest difference between the number of students who agreed versus disagreed any of the statements on the YSRM was with the statement *Adults of my race use math in their daily...*
lives. An overwhelming majority of respondents, 60% agreed with this statement compared to only 20% who disagreed with this statement.

Related to the previously stated results, another interesting finding was uncovered while conducting a statistical test for relationships amongst these questions and the demographics questionnaire. STEM majors were more likely to disagree with the statement that Black people are given as many opportunities to succeed in mathematics as people of other races than were non-STEM majors in this sample (Fisher’s Exact (2, n = 25), \( p = 0.033 \)). This may indicate that these STEM majors may have been discriminated against in their prior mathematics classes or possibly they have seen other students discriminated against.

**Culture and Mathematics**

Students described the term culture in various ways (see Chapter 5) especially centering around race more than anything. Other features that students included in their descriptions included religion, age, relationships with family and friends, geographical locations, climate, music, and language. Within these constructs were themes centered around (a) a sense of comfort and being comfortable around people they feel are in their culture and (b) a sense of pride and how they were proud to be within the culture they identified with. This discussion led into reasons students wanted to attend a Historically Black College/University (HBCU). The reasons students responded with centered around being able to see people who phenotypically look like themselves, to be a part of the “Black experience” that is uniquely located at an HBCU, and to have an already established support system when they need to access and/or provide support themselves.

These conversations surrounding culture and reasons for attending an HBCU evolved into how students thought about a course that got them thinking about these cultural aspects in
relation to the subject of mathematics and the experimental mathematics course they had just taken part in. From the interview data, we see that students thought that these lessons indeed achieved their intended purpose for they were seen as culturally specific by allowing students to make connections with their own lives; they were relevant and timely because these lessons were for the correct audience and up-to-date with today’s context; and they felt pedagogically different than how had experienced in previous mathematics courses.

**Connecting Race, Culture, and Mathematics**

The qualitative results from research question three surrounding cultural competence supports the quantitative findings. Looking at a key finding from the YSRM, we see that twelve percent more students disagreed with the statement that Black students are given as many opportunities to achieve in math as people of other races. This may indicate that students may have learned more about the sociopolitical happenings within America that helps lead to inequalities for minorities, such as the achievement gap, opportunity gap, incarceration disparities, etc. – some of which were discussed in the intervention lessons of incarceration and banking. From the interview data, students speak about how the information was eye-opening.

Tiffany said “the incarceration one is like… wow! Is that many people in jail!?? Like, Black people at that! It’s very informational, all that. I didn’t know that before.” Other students, like Matthew, speak more to this knowledge awakening by acknowledging the topics that were discussed in the course involved these salient issues, which brought students to an HBCU in the first place because they wanted a community in which they felt safe and comfortable talking about these issues.

**Matthew:** Definitely with the changing populations in race in America and then the incarceration [were lessons that addressed my culture in this class]. Today,
a lot of people see African-American, you automatically think bad sometimes. We talked about in these lessons, well... people made comments about how they always going to jail and stuff; drugs, you see a lot of people getting killed, police brutality, and stuff like that. I think we’re already at a disadvantage, so for us to fix that, it would take us all to come together as one and everything. But as to what was talked about in the class, I do believe the Black racial population and incarceration were very important things that are important today for us.

Another statement that speaks to the effect of culturally relevant pedagogy on this group was the large shift that occurred in the responses to the statement that adults of the students’ race used mathematics in their daily lives. This increased by a massive 38%. This statistical figure was also supported by the student interview data. Students were able to see how mathematics was, and could be used in several real-world situations.

**Lindsey:** It made me see that it’s a lot more real-world situations. Like, I would think about it but I was like, okay. maybe math is only involved in building buildings or stuff like that but I really didn’t see it any other way until we started talking about relatable things and saw, “ok… I see where the math can come in at.” It maybe doesn’t have to, but I see where it can be inserted.

From this statement by Lindsey, we can see that students come in with notions about what mathematics is and how it is used in very limited and for specific needs. This thinking evolved for Lindsey, after seeing how mathematics could be used and how is can be a tool for modeling the world.
There was quantitative evidence that showed that STEM majors disagreed more with the statement that Black people are given as many opportunities to succeed in mathematics as people of other races compared to that of non-STEM majors. I hypothesized that this could be an indication that the STEM majors in this course themselves could have been discriminated against in their prior mathematics classes or possibly they have seen other students discriminated against. One student, Jamie, spoke at length during the interview of experiences that she encountered in her previous mathematics classes that aligns with this voice.

**Jamie:** [W]here I'm from, the teachers, they try to help students, but like – they only pick certain students, so like either you catch on or you don't if you’re not one of the chosen few. No, [culture had not been discussed in my previous classes], but like my school was very racist. Ok. So, my high school is more predominately White students than there are African-Americans, but there are African-Americans in at high school. But like we get targeted. Like I was even targeted at myself because people knew I was raised in the hood, but people didn't know that I was very intelligent. So, like they just automatically thought I was not worthy of being in like, an advanced class or honors class stuff like that.

This was a student who had intentions on majoring a STEM-related discipline, but opted against it due to past negative experiences she had in a specific mathematics class.
CHAPTER 7: DISCUSSION

The purpose of this dissertation was to investigate the outcomes of students who participated in a course integrated with lessons that were based upon Gloria Ladson-Billings’ (1995a) theory of culturally relevant pedagogy. Specifically, this theory is founded upon three tenets: academic achievement, cultural competence, and sociopolitical consciousness. This study was framed with this theoretical and pedagogical approach. This chapter will be divided into these three areas with relation to the research questions that guided this study continuing discussions from the previous chapter. I will then situate the findings from this study within the larger context of prior research for each tenet of culturally relevant pedagogy. I will conclude this chapter and study by providing some implications, describe associated limitations and significant, and provide directions for future research.

Academic Achievement

Connecting Academic Achievement Results to the Literature

Results from these two research questions centered around academic achievement seem to align with prior literature. When the materials that students are engaging with utilize pedagogy that is in line with students’ cultures, a deeper understanding of mathematical concepts is had by students, which was true of this present study and one also seen in by Rubel and Chu (2011). By incorporating rich mathematical problems for students to work through and think through, students were provided the opportunity to learn mathematics in a way that was meaningful and relevant for them (Anhalt et al., 2018). Students demonstrated mathematical learning gains through various pre- and post-assessments through the culturally relevant pedagogy lessons. By providing students with culturally-rich and mathematically-rich pedagogy, students demonstrated their understanding of the mathematical concepts as well as gained a better affinity towards
mathematics as seen on their VAMS scores and in their interviews. These connections between culturally relevant pedagogy and higher scores on unit tests and other measures to quantify learning is one that occurs in the few quantitative studies centered on culturally relevant pedagogy (Ensign, 2003; Matthews et al., 2013). The connections between achievement and attitude towards mathematics was supported by my findings. Through the interviews, all students stated they enjoyed the cultural aspects of the course. Since they were able to see the connections with what they were learning and how it related to their own lives, their interest and confidence in their abilities increased. Not all students improved their attitudes towards the subject of mathematics, as was seen in a study by Hubert (2014). In particular, Kanisha and Ahshante were not completely void of negative attitudes towards the subject; however, they appreciated the change in the way the content was delivered in comparison to their previous mathematics courses.

Possibly the most important survey item from the VAMS that stood out was item seven: “For me, the relationship of mathematics courses to everyday life is usually: (a) hard to recognize; (b) easy to recognize.” This statement speaks to what culturally relevant pedagogy aims to do in merging context with content (Ye et al., 2011). Through using culturally relevant pedagogy, students were able to more easily view the world through a lens of mathematics. This was consistent with previous research (Langlie, 2008; Tate, 1995) that saw increased gains in the students that were able to create this link through the use of culturally relevant pedagogy.

Cultural Competence

Connecting Cultural Competence Results to the Literature

Some of the results of this study were also seen amongst other studies that utilized the Youth Survey on Race and Mathematics. The large shift that occurred in the responses to the
statement concerning adults who share the same race of the students using mathematics in their daily lives increased by a 38% after the duration of this intervention. This makes sense given the lessons grounded in higher-level tasks that incorporate the application of mathematics into real-world situations (Matthews et al., 2013; Smith & Stein, 1998). These students saw how the math was applied and worked together to see its applicability in normal, day-to-day activities. On the post-survey, 60% of respondents thought adults of their race used mathematics in their daily lives. These students saw how the math was applied and worked together to see its applicability in normal, day-to-day activities. This coupled with the comparison to another statement that people of their own race are typically good at math, only 20% of these students believed that people of their race were actually good at mathematics with and half of this group having no clue as to how assess the mathematical ability of African-Americans (see Table 23). These results are in alignment with what English-Clark (2011) experienced when she surveyed ninth and tenth graders, that most African-American participants perceived mathematics as something that adults of their race actually use in their day-to-day lives, and yet “they did not necessarily think that most people of their race are good in math, which suggests that many youth believe that in order to use math in real life, you do not necessarily have to be good at math” (p. 118).

Looking at the lessons themselves and students in relation with them, culturally relevant pedagogy has a historically been seen to lead to positive outcomes for students. In this study, this too holds true. Having lessons that connect with students’ cultural experiences, this study provided evidence that pedagogy of this form did keep students engaged throughout the duration of the classes (Gilbert et al., 2008) and it allowed students to make connections with mathematic sand students’ identities to see the usefulness and applicability of the mathematics (Jackson, 2013).
By being situated at college-level, state and national high stakes testing did not have as much a burden as it would at the K-12 level. This may help explain why results differed somewhat from some K-12 studies, such as one by Leonard, Napp, and Adeleke (2009) which found that some teachers were hesitant to fully implement lessons designed to be culturally relevant. This potentially halted some of the benefits that may have shown in their findings. Although this present study and another by Leonard and Dantley (2005) saw the incorporation of culturally relevant topics aided in students’ comfortability in classroom discussion. Being able to talk about salient topics and participate in discussions surrounding race and other sensitive topics in a mathematics classroom.

**Sociopolitical Consciousness**

The final tenet of culturally relevant pedagogy is sociopolitical consciousness. This, again, is concerned with providing experiences where students can critically think and critique society, and in the case of this dissertation study, using mathematics as the avenue to do this. The research concerned with this tenet was research question four: *How are college algebra students able to critique discourses of power using mathematics as a tool?* This question was explored solely using qualitative data from both portions of the interview and the mathematics reflection journals.

**Recognizing, Caring, Critiquing, and Acting**

The themes that transpired in all forms of data collection related to this research question embodied one of: recognizing that a problem existed, caring, critiquing, and acting. Students, through culturally relevant lessons, described how they felt after the lessons that they either did not know about certain issues, or just shocked to see the numbers in relation to them. Briefly, Tiffany, summed it up with this statement saying: “the incarceration one is like… wow! Is that
many people in jail!?? Like, Black people at that! It’s very informational, all that. I didn’t know that before.” Once they expressed or emphasized the situation, some empathized with the groups of people that were being discussed.

**Tiffany:** [These lessons] actually made me realize like this is really happening.

Like, this is actually life! It might not be affecting me personally, but a lot of people who look like me and that is just sad, honestly. It really got me thinking about how to prevent things like that from happening so often?

After caring about and empathizing with various people for various reasons, students moved to a more critical approach with their statements. Students began to critique various institutional systems including incarceration, education/college loan providers, and healthcare—all topics which had culturally relevant lessons build around them. After which, some students wanted to seek to change the various systems they had just critiqued.

These discussions led to the scenarios (two sociopolitical and one culturally specific) where students voiced their opinions and concerns. Again, students used these same themes of recognizing, caring, critiquing in order to explain how they would potentially act on these issues. Students were able to use the experimental lessons they had been a part of in various ways. One way was by using the mathematics that was leaned. For instance, Matthew expressed concerns with the idea of raising the minimum wage due to issues surrounding optimizing the set budget a school potentially has using quadratic profit and revenue equations.

**Matthew:** In my opinion, no [the minimum wage should not be increased to $10 or $15], because if you do that, then, I don’t know how much the school has to give out – but from what I would think, I would say no because if you do that, you wouldn’t be able to hire a lot of people. Some people’s hours
may get cut short. Maybe that’s when it could be shown using a graph; it'll probably be quadratic-looking because the higher the salary, the less people could be hired. Also, look at If you do raise it, how much money is left for the school to use for different things for stuff that we need, like athletics and stuff like that. You would see a lot of the important stuff is going down and then you just put two and two together and then you’ll see that you need to keep minimum wage what it is.

Students also used the structure of the experimental lessons themselves in order to explain what they would do. For example, Pamela explained how she wanted to compel change by using statistics and exploring data trends. She then would want to create equations in order to create a story she would like to portray.

**Pamela:** Oooh… I don’t know. Yeah, you use statistics. You throw the statistics at them. In the year 2000, this was a number, in the year 2005, it’s this number. And then you can combine them, and take them apart and pull different aspects and see how the numbers change. I know you could then make an equation, and you could definitely take a graph and have like the shootings of the year and then pull out, this is how many students, and this is how many males were unjustly killed…. Looking at percentages and ratios. You then take that graph and look at the next few years to show what would happen if this continued.

**Connecting Sociopolitical Consciousness Results to the Literature**

The ability to utilize mathematics in such a way that students find it useful and see its applicability in their day-to-day lives is a strong benefit for the advocation of such critical
mathematics pedagogy (Tate, 1995). It is important to mention again that the majority of these students will not take another mathematics class and that is something most of them are all-too-excited about. Although not quite the same as “liberatory pedagogy” (Lynn, 1999), students were still able to discuss difficult issues, such as the pervasiveness of racism in America (DeCuir & Dixson, 2004), the importance of cultural identity for African American students (D. B. Martin, 2009), and the intersection of class and race (Crenshaw, 1989, 1991) though the use of mathematics. This occurred during the classroom activities, themselves, but also during the interviews when they were asked to take stances or discuss their opinions on various topics. Evidence from this study shows that students were able to examine inequalities in various areas of life and expound upon their critiques of various issues in their local, state, and global community – such as the goal for this type of pedagogy (Gutstein, 2003).

**Implications**

One of the most important things I learned through this study was that I did not know to what extent culturally relevant pedagogy would have an effect on students. Prior literature gave some indication, but a lot more came from the data in this study. Students in my experimental group performed better than those in the control group on multiple measures of performance. The control group was experienced good tasks and good mathematics teaching, but culturally relevant pedagogy is beyond and more than just “good teaching.” There was an abundance of evidence in this study to support this conclusion. The way students were able to change their views about mathematics in the experimental course revealed that this shift was indicative of how these students now valued of importance of mathematics in everyday life. This evidence helps add to what the literature tells us about having a more positive view of mathematics being correlated to higher achievement for students of mathematics (Carlson, 1999). In the rest of this
section, I will discuss other implications for instructors, students, and researchers based on the impact of the results from this study.

**Implications for Mathematics Instructors**

As shown from evidence in this study, these lessons showed improvement in student outcomes, including student achievement (test and overall grades) in comparison with a control group, self-efficacy and affinity towards mathematics, and ability to critically think an utilize mathematics in meaningful ways. The use of culturally relevant pedagogy works in a variety of ways. These are the goals for the teaching and learning of mathematics, yet very few studies have shown that this is actually occurring in the K-12 space, nonetheless, at the collegiate level (Aronson & Laughter, 2016; Milner IV, 2017; Morrison et al., 2008). This study showed that in comparison to a control group, students had better scores and overall larger gains not only on class assessments and final grades from daily and normal course materials, but also on valid and reliable measures such as the Precalculus Concept Inventory (Carlson et al., 2010). Students improved their views about mathematics as seen on the Views About Mathematics Survey (Carlson, 1997). All these measurements were shown to be correlated with each other and that higher grades were also correlated with more “expert”-like views about mathematics.

In a time where many colleges and universities are paying lip-service to the term “diversity” and a self-purported push for the diversifying of their programs, African-American students are constantly performing below their peers in mathematics and other STEM-related coursework (Próspero & Vohra-Gupta, 2007; Roksa et al., 2017). Due to these barriers to achieving in mathematics courses (Barton, 2003; Saxe & Braddy, 2015), minority students are often oppressed under the guise of teachers “doing what is best for their students” (Higgins & Moule, 2009) or considering these practices as “good teaching”. Often, culturally relevant
pedagogy, when described, is met with the antiquated questions of: “isn’t this just good teaching?” The answer to this is yes, it is; however, it is much more than that as shown through this study. “Good teaching” is not enough. To better serve minority students and an overall diverse population, students need mathematics instruction that utilizes what they bring to the classroom through their past experiences. Instead of constantly focusing on what they do not know, the focus needs to be shifted to what know and how they can be best leveraged into making dynamic, student-centered lessons that are engaging for students. Culturally relevant pedagogy seeks to teach to the “whole child” and not just the academic part of them (Brown-Jeffy & Cooper, 2011). Through this pedagogy, students will be able to transfer skills learned in class to where it can be useful for them: in critical thinking, logical decision-making, and making stands on various issues using tools that they have at their disposal.

**Implications for Mathematics Teacher Educators**

Teacher training programs must lead the charge in developing the next generation of culturally relevant pedagogues. This study has help lay some of the groundwork at the collegiate level in showing that greater positive student outcomes were held at this level of education. This call for teacher educator especially extends to graduate programs in mathematics as well as mathematics education programs. This study concerns the teaching and learning at the collegiate-level, and typically instructors of mathematics at this level come from mathematics departments. To better serve and meet students where they are in order to get them where you want them to be, using the culture of students was shown to be a great start. Even more specifically, the education of students who take service-level mathematics courses like college-algebra need this pedagogy to get them more interested and have a better outlook on the subject of mathematics and its utility in the “real-world.”
For teachers who are already in the classrooms, teacher educator programs should provide professional development on culturally relevant pedagogy. Showing in-service teachers, the foundations and how to use students’ cultures in non-trivial and innovative ways to enhance their teaching practices will benefit already good teaching practices and make them better.

**Implications for Mathematics Students**

Students, themselves, also have a stake in their own education and educational practices that are designed for them. Culturally relevant pedagogy is a dynamic tool that makes learning mathematics meaningful and useful. For students taking service-level courses who may not take another mathematics course, making sure that this only course will set you up for future success in other endeavors is a strong reason to advocate for instruction that was designed with you in mind. Culturally relevant lessons are engaging, real-world connected, and informative about the community you are in and the larger society. All of these attributes help set the stage for a student-centered approach to learning.

**Implications for students attending historically Black colleges/universities.** The students at a historically Black college/university, specifically, could gain a lot from participating in a course designed like this one. For these mostly minority students, some of them may have not experienced a lot of success in mathematics, such as some of the students in this particular study. Many of these students go into math courses dreading the fact they have to take it. If they experience some success that is certainly a good thing. Even more, if these minority students realize that they enjoy mathematics because they see the usefulness and applicability to their real lives, they may actually want to pursue a major that is within a STEM field.
Implications for Future Research

Culturally relevant pedagogy offers a useful conceptualization when researching teaching and learning practices. Future research should be explored on how to expand the content to additional “gatekeeper” mathematics courses, such as precalculus, the calculus series, and introductory statistics. Looking at student engagement, student interactions, and classroom discourse by looking at live video footage from these courses while students are interacting in culturally relevant pedagogy activities could provide fascinating insights into further potential benefits for enacting such theory inside of a college classroom. More data needs to be collected on utilizing more lessons to find a correct number of lessons that should be implemented in order to maximize outcomes for students, while also keeping an eye to feasibility in planning and implementation by the instructors who actually come up with the content and enact it. This work suggests that an average of one lesson per unit could potentially be a starting point.

Remembering the charge to mathematics teacher education programs through implications above; changing perspectives and looking at this research from the perspective of preservice teachers and professional development with in-service teachers and their abilities to create lessons that are culturally relevant and their implementation with continued interest on how this work helps students learn and interact with each other and their teachers needs to be explored further. Along this line is also attempting to assess students’ sociopolitical consciousness was a challenging aspect of this dissertation study. Developing an instrument to attempt to measure this phenomenon would be something a researcher could do that would be of valuable interest, not only to this research, but to those studying culturally relevant pedagogy. Developing a quantitative measure would be of great interest to further explore culturally relevant pedagogy using a mixed methodological approach.
Finally, future research should take these culturally relevant pedagogy principles to colleges and universities that are predominantly White institutions, as also recommended by Sleeter (2012). Culture is not race-specific and thus could be used to improve learning outcomes for all students who may be struggling in service-level mathematics courses at various types of universities.

**Limitations**

The first limitation encountered with this study had to do with the sample size. This could have impacted this study in multiple ways. During the first half of a semester, students are enrolling and withdrawing sporadically. With the instability and uncertainty of who actually is or will be enrolled in a course made it difficult to know which groups of students to target lessons to. Problems concerning attendance of students is an institutional problem at Bernard St. Stephen University. This variability between groups concerning course size effected the statistical power of the quantitative results. Students self-selecting to have their work being included as a part of this study was also a limitation. Not having all measures included in statistical analyses certainly affects the variability amongst scores and may decrease the representativeness of the sample sizes in either group.

Another limitation (that is also seen as a strength) is the teacher-as-researcher. This was a limitation due to students potentially providing more favorable answers in order to make me feel better (even in lieu of me constantly asking them to give honest responses). There is the possibility that students did better because they perceived that they were receiving an instructional intervention designed to improve their mathematics achievement and views; however, the control group also received instructional interventions different from other standard sections of the course.
While implementing something that I truly believed in with the experimental group, it was difficult to not want to treat each course the same with the activities. I certainly adhered to my implantation plan in order to conduct the research properly and stick to this design to the best of my ability, but as with any instruction, the enacted curricula did not always perfectly align with the intended curricula (as noted in Table 7). Having only one control group, also taught by the researcher was also a limitation. Another control group (and/or experimental group) taught by a different instructor could have help mitigated this concern; however, with the timing of the course, the study, and multiple institutional review boards, this was not possible. Teacher-as-researcher was also a strength of this study. If you want to implement culturally relevant pedagogy done well, you need to have knowledge and experience with the pedagogical methods of such a learning theory. As students constantly warned in earlier chapters, this type of pedagogy cannot be done by just any person if the goal is for it to be done well.

Four lessons may also not be the correct number of lessons; however, again, due to the rigid nature and the fast pace at which concepts are introduced to students, and a common syllabus that is used for multiple sections of the course, I had little ability in vast sweeping changes. In order to make a course that is truly based on culturally relevant pedagogy principles, a near complete overhaul and restructuring of the course needs to be undertaken. Culturally relevant pedagogy should be interwoven throughout the entire semester. To do this in a rigid, and somewhat unforgiving course like College Algebra, would require really focusing on key topics and outcomes you had for students. This may mean deleting entire units in order to provide meaningful real-world interaction with the mathematics that is being learned. Possibly, if the concepts had to be learned as-is with no room for content changes, this course could be broken up over two semesters to fulfill the purposes for culturally relevant pedagogy and a five-unit
College Algebra course. This could; however, bring up more issues administratively than could be surmounted. It is a delicate balance when deciding how best to integrate culturally relevant pedagogy principles into a course, one which I intend to further research in order to optimize the benefits of this theory (as described in the Implications section of this chapter).

Finally, As discussed earlier in this chapter, a limitation arose during data collection when trying to “measure” students’ sociopolitical consciousness. I could not find a measure that would do this quantitatively, and the qualitative means to which I attempted to do this is a good start, but this provides another avenue for future research on such a measure. Related to this is the notion of pulling apart the tenets of culturally relevant pedagogy. This is also a limitation because the tenets are not mutually exclusive of each other. These ideas are related and integrated with each other so closely, so by pulling them apart to study them one might miss some of the important connections within and among these tenets. This point came out in some of the data analysis and results, for one tenet consistently informed the others during discussion of possible conclusions drawn from the data.

**Significance**

With all the limitations, there are were significant values that this study demonstrated that could truly impact the field of mathematics education in a powerful way. First, when it comes to the implementation of culturally relevant teaching, studies that are done are mostly qualitatively explored. This study added quantitative data in an area that has been heavily qualitatively explained. The qualitative aspects of this study were used to support the quantitative findings through a quasi-embedded mixed methods study. Another significant effect that this study had was the improvement to the practice of teaching at the college level – especially for the developmental mathematics courses, such as college algebra at this particular university. Lessons
have already been incorporated in similar courses due to the evidence provided by this study. As mentioned in the introductory pages of this proposal, students in courses like this one are subjected to nonstop direct lecturing which is leading to high failure rates (Barton, 2003; Ganter & Barker, 2004). If students are able to experience alternate forms of instruction weaved throughout a course like this one, in hopes to improve overall outcomes for minority students and increase their opportunity to achieve on all levels.

**Conclusion**

Historically, students taking college algebra and other introductory mathematics courses have struggled to “pass” these courses. This phenomenon is even more pronounced when looking specifically at minority students. When looking at what is taking place in collegiate mathematics classrooms, culture and the interests of students continue to lack a place within the day-to-day activities of classes, even if the courses are designed to be student-centered and less teacher-as-lecturer. In this small study, it was shown that by incorporating these facets of students’ lives can lead to positive effects on student outcomes.

Despite what we know about these equitable teaching practices, many instructors still fail to adapt to these culturally relevant teaching practices as sources for classroom content. I believe that through these teaching practices, academic achievement can be enhanced with culturally relevant materials. Cultural competence can also be experienced through appreciation and understanding for one’s culture, while also developing students’ sociopolitical consciousness; the ability to interact, understand, and critique the world around (near and far). These benefits are seen when trying to enhance and impact the educational experiences of underrepresented populations.
Investing time, energy, and other resources are needed and a crucial part to developing curricula that address these cultural concerns for students. Using Matthew, Jones, and Parker’s (2013) culturally relevant cognitively demanding (CRDC) task framework to model these lessons after can serve as a powerful tool in pushing towards becoming a culturally relevant pedagogue. From this tool, I graded the lessons I was trying to make culturally relevant for my student and revised them to make them stronger is various categories of it. Just as I tirelessly worked on developing lessons that would make an impact on students, so could others.

Research can continue to contribute compounding evidence that shows this pedagogy works for diverse students (and expanding groups) by utilizing the framework of culturally relevant pedagogy in hopes to improve the teaching and learning of college mathematics for all students.
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Appendix A: Student Informed Consent Form (Experimental Group)

North Carolina State University
INFORMED CONSENT
FORM for RESEARCH

Title of Study: Leveraging Culturally Relevant Pedagogy in a College Mathematics Classroom: A Mixed Methods Study
Principal Investigator: Gregory A, Downing
Faculty Sponsor: Karen Hollebrands

What are some general things you should know about research studies?
You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate, or to stop participating at any time without penalty. The purpose of research studies is to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher(s) named above.

What is the purpose of this study?
This study will investigate how teaching methods employed by college algebra instructors affect student understanding and affect.

What will happen if you take part in the study?
As a normal part of your curriculum, you will complete the following: Precalculus Concept Inventory, Student Attitudes Survey, Student Information Sheet, and Math Reflections. I am asking you to consent to allow me to use information from the Precalculus Concept Inventory, Student Attitudes Survey, Student Information Sheet, and Math Reflections as data for research. You will be required to complete Precalculus Concept Inventory, Student Attitudes Survey, Student Information Sheet, and Math Reflections for the course but you are not required to consent to allow me to use that information as data for research. Five class sessions will also be video recorded. If you wish not to be included in the videos, you may sit outside of the camera’s view, as the camera will only point towards the students wishing to be viewed.

Risks
Participation in this study will involve an assessment and possibly being videotaped during class. Nothing reported during this study will have an impact on your GPA or affect any grades in any of your courses.

Benefits
There are no direct benefits. Participating in educational research allows our educational system to grow and serve our students better in the future. As a participant in this study, you would be providing valuable information to the scientific community of educational researchers, and are contributing to help improve and adapt college mathematics education experiences for future students.
Confidentiality
The information in study records will be kept confidential to the full extent allowed by law. Data will be stored securely in password protected computers/files, as well as maintained in locked filing cabinets. No reference will be made in oral or written reports which could link you to the study.

Will this affect my grade?
Activities that are conducted as a part of this study are a part of your normal course activities. You will, therefore, receive only a grade for completion of assignments/activities, not a grade based on effort/merit. Your grade will not be affected based on whether you give consent or not to allow your information to be used as research.

What if you have questions about this study?
If you have questions at any time about the study or the procedures, you may contact the researcher, Gregory Downing, at (252) 333-6865 or at gadownin@ncsu.edu.

What if you have questions about your rights as a research participant?
If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact the NCSU IRB office at irb-director@ncsu.edu or by phone (919-515-4514).

Consent to Participate
“I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled.

Please check the appropriate box:

☐ I agree to participate in this study (my responses can be used for this research.
☐ I choose not to participate in this study.

Participant's name ____________________________ Date ________________

Participant's signature _________________________ Date ________________

Investigator's signature ________________________ Date ________________
Appendix B: Student Informed Consent Form (Control Group)

North Carolina State University

INFORMED CONSENT

FORM for RESEARCH

Title of Study: Leveraging Culturally Relevant Pedagogy in a College Mathematics Classroom: A Mixed Methods Study

Principal Investigator: Gregory A. Downing

Faculty Sponsor: Karen Hollebrands

What are some general things you should know about research studies?
You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate, or to stop participating at any time without penalty. The purpose of research studies is to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher(s) named above.

What is the purpose of this study?
This study will investigate how teaching methods employed by college algebra instructors affect student understanding and affect.

What will happen if you take part in the study?
As a normal part of your curriculum, you will complete the following: Precalculus Concept Inventory, Student Attitudes Survey, and a Student Information Sheet. I am asking you to consent to allow me to use information from the Precalculus Concept Inventory, Student Attitudes Survey, and a Student Information Sheet as data for research. You will be required to complete Precalculus Concept Inventory, Student Attitudes Survey, and a Student Information Sheet for the course but you are not required to consent to allow me to use that information as data for research.

Risks
Participation in this study will involve an assessment and surveys. Nothing reported during this study will have an impact on your GPA or affect any grades in any of your courses.

Benefits
There are no direct benefits. Participating in educational research allows our educational system to grow and serve our students better in the future. As a participant in this study, you would be providing valuable information to the scientific community of educational researchers, and are contributing to help improve and adapt college mathematics education experiences for future students.
Confidentiality
The information in study records will be kept confidential to the full extent allowed by law. Data will be stored securely in password protected computers/files, as well as maintained in locked filing cabinets. No reference will be made in oral or written reports which could link you to the study.

Will this affect my grade?
Activities that are conducted as a part of this study are a part of your normal course activities. You will, therefore, receive only a grade for completion of assignments/activities, not a grade based on effort/merit. Your grade will not be affected based on whether you give consent or not to allow your information to be used as research.

What if you have questions about this study?
If you have questions at any time about the study or the procedures, you may contact the researcher, Gregory Downing, at (252) 333-6865 or at gadownin@ncsu.edu.

What if you have questions about your rights as a research participant?
If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact the NCSU IRB office at irb-director@ncsu.edu or by phone (919-515-4514).

Consent to Participate
*I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled.

Please check the appropriate box:

☐ I agree to participate in this study (my responses can be used for this research.
☐ I choose not to participate in this study.

Participant’s name_______________________________ Date _________________
Participant’s signature____________________________ Date _________________
Investigator's signature___________________________ Date _________________
Appendix C: Student Informed Consent Form (Interview Form)

North Carolina State University

INFORMED CONSENT

FORM for RESEARCH

Title of Study: Leveraging Culturally Relevant Pedagogy in a College Mathematics Classroom: A Mixed Methods Study

Principal Investigator: Gregory A. Downing

Faculty Sponsor: Karen Hollebrands

What are some general things you should know about research studies?
You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate, or to stop participating at any time without penalty. The purpose of research studies is to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher(s) named above.

What is the purpose of this study?
This study will investigate how teaching methods employed by college algebra instructors affect student understanding and affect.

What will happen if you take part in the study?
If you agree to participate in this study, you will be interviewed and videotaped for approximately 60 minutes. This interview will consist of two phases. The first phase will ask you questions about the course you were just a part of. The second phase of the interview will require you to complete a math task and explain your reasoning and thought processes throughout.

Risks
Participation in this study will involve you being videotaped during the interview. Nothing reported during this study will have an impact on your GPA or affect any grades in any of your courses. Further, interviews are voluntary and you may decline and it will not affect your grade or class standing.

Benefits
There are no direct benefits. Participating in educational research allows our educational system to grow and serve our students better in the future. As a participant in this study, you would be providing valuable information to the scientific community of educational researchers, and are contributing to help improve and adapt college mathematics education experiences for future students.
Confidentiality
The information in study records will be kept confidential to the full extent allowed by law. Data will be stored securely in password protected computers/files, as well as maintained in locked filing cabinets. No reference will be made in oral or written reports which could link you to the study.

Compensation
Upon completion of the interview, you will be given a $30 stipend to use as you wish for your time. If you withdraw from the interview prior to its completion, your data will be destroyed and you will not receive any compensation.

Will this affect my grade?
Your grade will not be affected based on whether you give consent or not to allow your information to be used as research.

What if you have questions about this study?
If you have questions at any time about the study or the procedures, you may contact the researcher, Gregory Downing, at (252) 333-6865 or at gadownin@ncsu.edu.

What if you have questions about your rights as a research participant?
If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact the NCSU IRB office at irb-director@ncsu.edu or by phone (919-515-4514).

Consent to Participate
“I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled.

Participant’s name_______________________________ Date _________________
Participant’s signature___________________________ Date _________________
Investigator's signature___________________________ Date _________________
Appendix D: Culturally Relevant Cognitively Demanding (CRCD) Task Rubric

<table>
<thead>
<tr>
<th>Description</th>
<th>Degree in Task Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mathematics task explicitly requires students to inquire (at time problematically) about themselves, their communities, and the world about them.</td>
<td>High (3)</td>
</tr>
<tr>
<td>2. May draw from connections to other subjects and issues.</td>
<td>Moderate (2)</td>
</tr>
<tr>
<td>3. Mathematics task draws from students’ community and cultural knowledge.</td>
<td>Low  (1)</td>
</tr>
<tr>
<td>4. Task may explicitly seek to add to this knowledge through mathematical activity.</td>
<td></td>
</tr>
<tr>
<td>5. Task is mathematically rich and cognitively demanding, embedded in cultural activity.</td>
<td></td>
</tr>
<tr>
<td>6. Task asks students to engage the discontinuity and divide between school and their own lives – home and school.</td>
<td></td>
</tr>
<tr>
<td>7. Task is real-world focused, requiring students to make sense of the world through mathematics.</td>
<td></td>
</tr>
<tr>
<td>8. The explicit goal of the task is to critique society – that is, make empowered decisions about themselves, communities and world.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix E: Demographics Questionnaire

1. What is your email address? (e.g. JaneDoe@email.edu)

2. Did you enter [this university] immediately after high school?
   a. Yes
   b. No

3. What is your date of birth?

4. What is your gender?
   a. Female
   b. Male
   c. Other: _________________
   d. Prefer not to answer.

5. What ethnic group do you identify most with?
   a. African American/Black
   b. Hispanic/Latino
   c. Asian/Pacific Islander
   d. Native American
   e. Caucasian
   f. Other: _________________
   g. Prefer not to answer.

6. What is your anticipated final grade in MATH 1100: College Algebra and Trigonometry?
   a. A
   b. B
   c. C
   d. D
   e. F

7. Is the Fall 2018 semester the first time you have taken MATH 1100?

8. List any other MATH courses you have taken at [the site institution]. Please also indicate if you have had to retake any course and the number of times.

9. For the course(s) listed above, what grade(s) did you earn?
10. What is the next mathematics course you plan to take, if any?

11. What is your major? (e.g. Nursing, Business, Mathematics, etc.)

12. What is your academic standing?
   - a. Freshman/First Year
   - b. Sophomore
   - c. Junior
   - d. Senior
   - e. Other: ______________

13. What is your enrollment status?
   - a. Full-time
   - b. Part-time

14. What is your work status?
   - a. Full-time
   - b. Part-time
   - c. Unemployed

15. What semester and year did you take your first class at [this university]? (e.g. Fall 2018)

16. What is your GPA?
   - a. 0.0 – 0.999
   - b. 1.0 – 1.999
   - c. 2.0 – 2.999
   - d. 3.0 – 3.999
   - e. 4.0
   - f. First year student; no GPA.
Appendix F: Precalculus Concept Inventory Items

Name: _____________________________________________
Date: ______________________________________________
Instructor/Teacher: ___________________________________

Directions: Please show all your work directly on this exam to the right or below each question.

1) Given the function \( f \), defined by \( f(x) = 3x^2 + 2x - 4 \), find \( f(x + a) \).
   a) \( f(x + a) = 3x^2 + 3a^2 + 2x + 2a - 4 \)
   b) \( f(x + a) = 3x^2 + 6ax + 3a^2 + 2x - 4 \)
   c) \( f(x + a) = 3(x + a)^2 + 2(x + a) - 4 \)
   d) \( f(x + a) = 3(x + a)^2 + 2x - 4 \)
   e) \( f(x + a) = 3x^2 + 2x - 4 + a \)

2) Use the graph of \( f \) to solve \( f(x) = -3 \) for \( x \).
   a) (-3,-2)
   b) -4
   c) (-4,-3)
   d) -2
   e) -3
3) Which one of the following formulas defines the area, $A$, of a square in terms of its perimeter, $p$?

a) $A = \frac{p^2}{16}$

b) $A = s^2$

c) $A = \frac{p^3}{4}$

d) $A = 16s^2$

e) $p = 4\sqrt{A}$

Use the graphs of $f$ and $g$ to answer items 4 and 5.

4) Use the graphs of $f$ and $g$ to evaluate $g(f(2))$.

a) -2

b) 1

c) 3

d) -4

e) Not defined

5) Evaluate $f(2) - g(0)$.

a) -4

b) -2

c) 0

d) 2

e) 4

6) The model that describes the number of bacteria in a culture after $t$ days has just been updated from $P(t) = 7(2)^t$ to $P(t) = 7(3)^t$. What implications can you draw from this information?

a) The final number of bacteria is 3 times as much of the initial value instead of 2 times as much.

b) The initial number of bacteria is 3 instead of 2.

c) The number of bacteria triples every day instead of doubling every day.

d) The growth rate of the bacteria in the culture is 30% per day instead of 20% per day.

e) None of the above.
7) A hose is used to fill an empty wading pool. The graph shows volume (in gallons) in the pool as a function of time (in minutes). Which of the following defines a formula for computing the time, \( t \), as a function of the volume, \( v \)?

\[
\begin{array}{c|c|c}
\text{volume} & \text{time} & \text{Formula} \\
--- & --- & --- \\
3 & 1 & a) \quad v(t) = \frac{t}{2} \\
2 & 2 & b) \quad t(v) = 2v \\
1 & 3 & c) \quad t(v) = \frac{v}{2} \\
\end{array}
\]

d) \( v(t) = 2t \)  

e) None of the above

8) Given the table to the right, determine \( f(g(3)) \).

\[
\begin{array}{|c|c|c|}
\hline
x & f(x) & g(x) \\
\hline
-2 & 0 & 5 \\
-1 & 6 & 3 \\
0 & 4 & 2 \\
1 & -1 & 1 \\
2 & 3 & -1 \\
3 & -2 & 0 \\
\hline
\end{array}
\]

a) 4  

b) -1  

c) 0  

d) 1  

e) 5

9) Given that \( f \) is defined by \( f(t) = 100^t \), which of the following is a formula for \( f^{-1} \)?

\[
\begin{array}{c}
a) \quad f^{-1}(t) = \frac{1}{100^t} \\
b) \quad f^{-1}(t) = \frac{t}{\ln 100} \\
c) \quad f^{-1}(t) = \frac{t}{100^t} \\
d) \quad f^{-1}(t) = \frac{\ln t}{\ln 100} \\
e) \quad f^{-1}(t) = \frac{\ln t}{100}
\end{array}
\]
10) Given the function \( h(x) = 3x - 1 \) and \( g(x) = x^2 \), evaluate \( g(h(2)) \).

   a) 10
   b) 11
   c) 20
   d) 25
   e) 36

11) What is the domain of the following function: 
\[
   f(x) = \frac{\sqrt{x + 2}}{x - 1}
\]

   a) \((1, \infty)\)
   b) \(x \neq 1\)
   c) \([-2, 1) \cup (1, \infty)\)
   d) \([-2, \infty)\)
   e) All real numbers

12) A baseball card increases in value according to the function, \( b(t) = \frac{5}{2} t + 100 \), where \( b \) gives the value of the card in dollars and \( t \) is the time (in years) since the card was purchased. Which of the following describe what \( \frac{5}{2} \) conveys about the situation?

   I. The card’s value increases by $5 every two years.
   II. Every year the card’s value is 2.5 times greater than the previous year.
   III. The card’s value increases by \( \frac{5}{2} \) dollars every year.

   a) I only
   b) II only
   c) III only
   d) I and III only
   e) I, II and III

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Appendix G: Views About Mathematics Survey

This survey is designed by the Modeling Instruction and ACEPT research teams at Arizona State University. It is intended to identify factors that affect people’s understanding of mathematics, and to assist in the design of instructional material.

Your participation is voluntary. The results will not affect your grade, even if you choose not to participate. All data are confidential. Your identity will not be disclosed to any party. Return of the survey materials will be considered your consent to participate.

Please:
Do not write anything on this questionnaire.
Mark your answers on the computer.
Make only one mark per item.
Do not skip any question.
Avoid guessing. Your answers should reflect what you actually and honestly think.
Plan to finish the survey in 20 minutes.

The example below illustrates the eight choices that you have for answering questions 1 through 33 in this section. Please mark your answers to these questions on the computer.

<table>
<thead>
<tr>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning mathematics requires:</td>
</tr>
<tr>
<td>(a) a serious effort.</td>
</tr>
<tr>
<td>(b) a special talent.</td>
</tr>
<tr>
<td>What would each one of the eight choices mean?</td>
</tr>
<tr>
<td>1. Only (a), Never (b): Learning mathematics requires <strong>only</strong> a serious effort and <strong>no</strong> special talent <strong>at all</strong>.</td>
</tr>
<tr>
<td>2. Mostly (a), Rarely (b): Learning mathematics requires <strong>far more</strong> a serious effort than a special talent.</td>
</tr>
<tr>
<td>3. More (a) Than (b): Learning mathematics requires <strong>somewhat more</strong> a serious effort than a special talent.</td>
</tr>
<tr>
<td>4. Equally (a) &amp; (b): Learning mathematics <strong>equally</strong> requires <strong>both</strong> a serious effort and a special talent.</td>
</tr>
<tr>
<td>5. More (b) Than (a): Learning mathematics requires <strong>somewhat more</strong> a special talent than a serious effort.</td>
</tr>
<tr>
<td>6. Mostly (b), Rarely (a): Learning mathematics requires <strong>far more</strong> a special talent than a serious effort.</td>
</tr>
<tr>
<td>7. Only (b), Never (a): Learning mathematics requires <strong>only</strong> a special talent and no serious effort <strong>at all</strong>.</td>
</tr>
<tr>
<td>8. Neither (a) Nor (b): Learning mathematics requires <strong>neither</strong> a special talent nor a serious effort.</td>
</tr>
</tbody>
</table>
1. Learning mathematics requires:
   (a) a serious effort.
   (b) a special talent.

2. If I had a choice:
   (a) I would never take any mathematics course.
   (b) I would still take mathematics for my own benefit.

3. Reasoning skills that are taught in mathematics courses can be helpful to me:
   (a) in my everyday life.
   (b) if I were to major in mathematics or a related field.

4. I study mathematics:
   (a) to satisfy course requirements.
   (b) to learn useful knowledge.

5. My score on mathematics exams is a measure of how well:
   (a) I understand the covered material.
   (b) I can do things the way they are done by the teacher or in some course materials.

6. For me, doing well in mathematics courses depends on:
   (a) how much effort I put into studying.
   (b) how well the teacher explains things in class.

7. When I experience a difficulty while studying mathematics:
   (a) I immediately seek help, or give up trying.
   (b) I try hard to figure it out on my own.

8. When studying mathematics in a textbook or in course materials:
   (a) I find the important information and memorize it the way it is presented.
   (b) I organize the material in my own way so that I can understand it.

9. For me, the relationship of mathematics courses to everyday life is usually:
   (a) easy to recognize.
   (b) hard to recognize.

10. In mathematics, it is important for me to:
    (a) memorize technical terms and mathematical formulas.
    (b) learn ways to organize information and use it.
11. Mathematical formulas:
   (a) express meaningful relationships among variables.
   (b) provide ways to get numerical answers to problems.

12. After I go through a mathematics text or course materials and feel that I understand them:
   (a) I can solve related problems on my own.
   (b) I have difficulty solving related problems.

13. The first thing I do when solving a real world problem that involves mathematics is:
   (a) represent the situation with sketches and drawings.
   (b) search for formulas that relate givens to unknowns.

14. In order to solve a mathematics problem, I need to:
   (a) have seen the solution to a similar problem before.
   (b) apply general problem solving techniques.

15. For me, solving a mathematics problem more than one way:
   (a) is a waste of time.
   (b) helps develop my reasoning skills.

16. After I have answered all questions in a homework mathematics problem:
   (a) I stop working on the problem.
   (b) I check my answers and the way I obtained them.

17. After the teacher solves a mathematics problem for which I got a wrong solution:
   (a) I discard my solution and learn the one presented by the teacher.
   (b) I try to figure out how the teacher’s solution differs from mine.

18. How well I do on mathematics exams depends on how well I can:
   (a) recall material in the way it was presented in class.
   (b) do tasks that are somewhat different from ones I have seen before.

19. In order to prove a mathematical theorem, one must:
   (a) produce evidence from the physical world.
   (b) provide a logically sound argument.

20. When they represent relationships in the physical world, mathematical functions are:
   (a) exact expressions of what is being represented.
   (b) approximate expressions of what is being represented.
21. After a theorem has been proven and accepted in mathematics:
   (a) it will never be changed.
   (b) it may be rejected at a future time.

22. The relationship among the sides of a right triangle expressed in the Pythagorean theorem is true because it has been:
   (a) proven by a logical argument.
   (b) verified by measurement.

23. Collecting and graphing real world data is useful for:
   (a) determining patterns and making general predictions.
   (b) obtaining numerical answers to specific problems.

24. For me, making unsuccessful attempts when solving a mathematics problem is:
   (a) a natural part of my pursuit of a solution to the problem.
   (b) an indication of my incompetence in mathematics.

25. When solving a challenging mathematics problem, a mathematician:
   (a) makes many incorrect attempts.
   (b) moves directly to a correct solution.

26. If we want to apply a method used for solving one mathematics problem to another problem, the objects involved in the two problems must be:
   (a) identical in all respects.
   (b) similar in some respects.

27. Different branches of mathematics, like geometry and algebra:
   (a) are related by common principles.
   (b) have no relationship to one another.

28. Scientists use mathematics as:
   (a) a tool for analyzing and communicating their ideas.
   (b) a source of factual knowledge about the natural world.

29. For me, solving a problem that involves mathematical reasoning is:
   (a) an enjoyable experience.
   (b) a frustrating experience.
30. Graphing calculators and computers:
   (a) bring new methods for solving mathematics problems.
   (b) speed up problem solving using established methods.

31. Using graphing calculators or computers:
   (a) increases my interest in studying mathematics.
   (b) is a waste of time.

32. In solving mathematics problems, graphing calculators or computers help me:
   (a) understand the underlying mathematical ideas.
   (b) obtain numerical answers to problems.

33. I answered all the questions in the survey:
   (a) to the best of my ability.
   (b) without thinking seriously about them.
Appendix H: Youth Survey on Race and Mathematics

Your Experiences with Math and Race

In this section of the survey, there are a series of statements. Circle the answer that shows how much you agree with the statement. There are no "right" or "wrong" answers. The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help you make a choice. Do not spend too much time on any one statement.

Strongly Agree – Agree – Not Sure – Disagree – Strongly Disagree

1. I have experienced racial discrimination.
2. At some point, I have felt like a math teacher really liked me or thought I could do very well in math.
3. At some point, I have felt like a math teacher didn't like me or didn't think I could do very well in math.
4. I have been discriminated against by a math teacher because of my race.
5. I have been helped by a math teacher because of my race.
6. At some point, I felt like a fellow student thought I could do very well in math,
7. At some point, I felt like a fellow student didn't think I could do very well in math,

Attitudes about Math and Race

In this section, there are a series of statements. Circle the answer that shows how much you agree with the statement.

Strongly Agree – Agree – Not Sure – Disagree – Strongly Disagree

1. People of my race are typically good at math.
2. Black people are given as many opportunities to succeed in mathematics as people of other races.
3. Adults of my race use math in their daily lives.
4. Blacks/African Americans are held back in math because of their race.
5. Asian Americans are better in math than people of other races.
Appendix I: Mathematics Journal Reflection Questions

Please respond with honest answer, writing as much or as little as you like. Thank you.

Name (First Last):
Today’s Date:

1. What did you like or dislike about today’s lesson?

2. In what ways did the mathematics lesson require you to inquire about yourself, your community, and/or the world around you?

3. How did the lesson connect to other subjects and/or topics beyond mathematics?

4. How did the task draw from your knowledge of topics that are relevant to you (including your interests or things happening in the community, country, or world)?

5. What specific mathematics topics did you just learn or have experience with?

6. What specific aspects of the lesson or mathematics connected you to your personal life?

7. How did the mathematics you just learned enable you to address an issue related to politics or social justice?

8. How did the lesson today contribute to your confidence in being able to solve mathematics problems?

9. Did this lesson change your thoughts about math? Explain.
Appendix J: Student Interview Protocol

Introduction
- Thanks for coming in
- The purpose of the interview
- If any questions you do not want to answer
- Your answers will not affect your grade, since the semester is over and grades are turned in.
- Sign the IRB informed consent form
- Please be open and honest with your responses. I am not looking for you to say any specific thing. You will not hurt my feelings with any responses you give.

Part I – The Class

Questions about the Course
1. What did you think about the course this semester?
2. What was your favorite part of the course? Why?
3. What was your least favorite part of the course? Why?
4. What did you think about these lessons?
5. Was the way these lessons were taught helpful to you?
6. Do you think other math classes should include lessons like these?

Academic Achievement and Mathematical Identity
1. What are your thoughts about the subject of mathematics?
2. Did this course change those thoughts about math? Explain.
3. Was this course easier, harder, or the same level of difficulty compared to previous mathematics courses you’ve taken?
   a. Follow up: Do you think the grade you earned in this course reflect what you feel you have learned?
4. Did your experiences in this course change your perceptions about your mathematical abilities?
5. Did the course influence your confidence to learn mathematics?
6. Did the course influence your ability to do mathematics?

Cultural Competence
1. You decided to attend this HBCU. Why?
2. What would you describe as your culture?
3. To what extent was your culture talked about in this mathematics class?
4. To what extent was the culture of other people discussed?
5. Has culture been discussed in your previous mathematics courses?
   a. If so, who’s culture?
6. Should culture be talked about in math at all?
   a. If so, why? --- Should it also be talked about in other courses?
   b. If not, in what courses is it more appropriate to discuss culture?
Sociopolitical Consciousness
1. What political or social topics do you remember being discussed during this class?
2. How did discussing these topics during class make you feel?
3. Do you think discussing these topics using mathematics is helpful? Explain.
4. Since participating in these activities in class, are there particular issues in your local community about which you’ve become more aware?
   a. In what ways could math be used as a tool in either understanding the issue, addressing the issue, or solve the problem?

Part II: The Issue and Mathematics

Questions:

1. There are some jobs in the university, especially those for students, where some people are making minimum wage at $7.25 per hour. People have been talking about raising the minimum wage to either $10 per hour or even $15 per hours.
   a. Do you think we should raise the minimum wage? Explain.
   b. To support your position, in what ways could mathematics be used?

2. Remembering the class after Halloween, people went to a lot of different parties the night before. So, in deciding which party to go to is there mathematics involved in that?

3. As I am sure you are familiar with news stories about unarmed Black-Americans being killed by police officers in America, what are your thoughts towards this?
   a. Who, if anyone, has the power to affect change or impact such shootings?
   b. How, if possible, can you use mathematics to address this situation and help you enhance your arguments?

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