THE ROLE OF CULTURALLY RESPONSIVE MATH TEACHING WITHIN ADOLESCENT STUDENTS' BIO-ECOLOGICAL SYSTEMS

by

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ABSTRACT

Current literature suggests that culturally responsive teaching practices are key to building students' academic interests, confidence, and achievement. These effects are especially true for racially and ethnically minoritized students. However, few quantitative studies have examined student self-reported experiences with culturally responsive teaching in middle school and high school. Using a QuantCrit methodology, this study positioned middle and high school students' (n=186) culturally responsive teaching experiences within a bio-ecological systems framework to explore the following: 1) whether culturally responsive teaching in math class predicts math engagement, and 2) if culturally responsive teaching is associated with interpersonal relationships at school. Additionally, using the bio-ecological systems framework, this study explored what a Professional Learning Partnership offered to facilitate the extent to which students received culturally responsive teaching in math class. Specifically, data came from a longitudinal study on Professional Learning Partnerships, in which school districts formed coalitions with organizations to improve curricula and teacher professional learning.

In sum, results did not demonstrate a significant relationship between culturally responsive teaching and engagement. However, there was a positive association with interpersonal relationships at school. Further analysis of the Professional Learning Partnership's goals delineated their emphasis on supporting teachers with instructing emerging bilingual students through culturally responsive strategies. Such strategies included facilitating family engagement in school, providing

teachers with professional learning modules on supporting emerging bilingual students, and creating peer support networks for teachers. The findings of this study may impel researchers and policymakers involved in education to utilize a bio-ecological systems perspective in evaluating the trajectory of culturally responsive teaching.

Chapter 1

INTRODUCTION

In addition to literacy, mathematics remains one of the most crucial subjects for building students' critical thinking and problem-solving skills. As such, educational stakeholders have given much attention to bolstering youth's math outcomes (Benson-O'Connor et al., 2019). However, inequitable practices in mathematics instruction in the United States have negatively affected academic performance outcomes for youth of color, girls, and immigrant youth (Else-Quest et al., 2013; Joseph et al., 2016; Riegle-Crumb, 2006). Evidently, disparities in mathematics performance result from negative narratives and biases that demean the abilities of youth from different racial and cultural groups (Battey & Leyva, 2018; Joseph et al., 2021; Larnell et al., 2016; Martin et al., 2010; Nasir et al., 2017; Vakil & Ayers, 2019). For instance, Battey and Leyva (2018) explored the role of implicit or internalized negative racial attitudes in mathematics teaching. They suggested that teachers' witnessing of frequent messaging about Black and Latinx students underperforming in math inadvertently fueled their internalized negative beliefs and expectations. As a result of these internalized biases, Latinx and Black students were more likely to be taught mathematics using rote, procedural strategies that limited possibilities for increased engagement and conceptual understanding. Educational researchers, policymakers, and classroom educators themselves have worked to address such oppressive practices. One of the most promising of such practices include those that are culturally responsive (Gay, 2000; Muñiz, 2019).

This study draws from Geneva Gay’s (2000; 2018) tenets of culturally responsive teaching and Urie Bronfenbrenner’s (1979; 1994) bio-ecological systems theory. Culturally responsive teaching is a method of academic instruction that imports race, culture, and students’ lived experiences into discussions, activities, and into the curriculum to facilitate academic success (Gay, 2000; 2010; 2018). In addition to cultural nuances, educational stakeholders need to be better attuned to the developmental processes informing how youth learn and the factors that frame it. Bronfenbrenner’s bio-ecological systems is useful for this purpose. Bio-ecological systems are defined as the comprehensive elements (e.g., societal systems, culture, interpersonal relationships, generational time, and biological processes) that affect the course of an individual’s developmental outcomes in domains like school (Bronfenbrenner, 1979; 1994; 2005). In this study, I seek to explore how schools can overcome disparities seen in mathematics by connecting the educational theoretical framework set forth by culturally responsive teaching to the developmental theory of bio-ecological systems.

Scope of this Study

This study utilizes culturally responsive teaching in addition to Bronfenbrenner’s bio-ecological systems theory to understand the scope of students’ academic engagement in math and their interpersonal relationships at school.

Particularly, I focus on students who are in their early and middle adolescent stages (i.e., middle school and high school students) since these periods involve rapid changes to social and cognitive processes that influence academic interests and goals (Chen et al., 2018; Rockoff & Lockwood, 2010). Research suggests that culturally responsive teaching practices positively affect developmental processes, such as overall social and emotional wellbeing (Barnes & McCallops, 2019). Culturally responsive teaching practices in math and its suggested positive outcomes could prove to be invaluable to adolescent students, however, the extent to which culturally responsive teaching comes into play is contingent on the schooling context in which adolescents grow and adapt (Cantor et al., 2021). Bio-ecological systems theory describes these systems that nurture the course of adolescent students' educational outcomes.

To begin, I describe the theoretical frameworks of culturally responsive teaching and bio-ecological systems in Chapter two. In Chapter three, I review the literature on culturally responsive teaching and its relevance to adolescent student outcomes in math. Next, in Chapters four through five, I present my research questions, and describe my methodology and analysis. This study's methodology draws from principles of QuantCrit, which is an approach that integrates critical race theory into quantitative data collection, analysis, and interpretation (Garcia et al., 2018; Gillborn et al., 2018). In education research, critical race theory "is a radical critique of both the status quo and the purported reforms," where investigating inequities involves a deeper analysis of the role that race plays in teaching strategies, curricula, and policies (Ladson-Billings & Tate, 1995, p. 62). While quantitative work cannot fully reveal peoples' nuanced, complex experiences, QuantCrit helps to illuminate patterns associated with oppression, cultural biases, or harmful beliefs that are culprits of inequities in math outcomes. I primarily make use of QuantCrit to guide my discussion of the results. I present results in Chapter six, and a discussion in Chapter seven. Finally, I conclude with implications for researchers and practitioners in Chapter eight.

Chapter 2

THEORETICAL FRAMEWORKS

Culturally Responsive Teaching

Geneva Gay (2000) formulated the theory of culturally responsive teaching. Culturally responsive teaching posits that teaching towards academic success should accommodate students' cultures, ideas, prior knowledge, values, and identities (2000; 2010). This teaching practice aims to widen students' perspectives through working with peers, learning from different scholars from various cultures, and so on (Gay, 2018). Based on prior observations of different classrooms and teaching styles, Gay (2000; 2010; 2018) explained that demonstrating cultural responsiveness involves being cognizant of cultural, socioeconomic, and racial diversity in classrooms, and adjusting instructional practices and curriculum delivery to accommodate and affirm students' backgrounds.

Gay (2018) proposed eight features that define culturally responsive teaching. The first involves encapsulating a classroom environment that validates and affirms students' unique cultural backgrounds and experiences. Doing this involves acknowledging contributions from scholars who students can identify with based on their own backgrounds, incorporating multicultural resources, and linking their lived experiences and prior knowledge to newer ideas. In mathematics, an example could be constructing problems based on recipes, places, names, and things that students can identify or relate to, discussing how different cultures or societies use math, and demonstrating the contributions of individuals from ethnically, racially, or culturally diverse backgrounds who have positively influenced the discipline of math (e.g., Averill et al., 2009).

The second characteristic of culturally responsive teaching is making the classroom environment inclusive by limiting competition between peers. Holding students to high expectations and providing unconditional encouragement and support are important components of a collective and inclusive classroom environment. In math class, creating a supportive environment can improve students' experiences with group work or projects, and subsequently facilitate their abilities to learn new ways of solving problems and gain different perspectives from peers (Gutstein, 2016).

The third characteristic is recognizing that culture is multidimensional and cultural assets can be honored in multiple forms. Gay (2018) described this as encompassing various dimensions, such as "curriculum content, learning context, classroom climate, student-teacher relationships, instructional techniques, classroom management…" (p. 39). As such, culturally responsive teaching is not just involved with delivering a lesson; it transcends into other aspects of students' lives and interests. For instance, in math, teachers can design projects that apply students' home or neighborhood experiences to mathematical concepts and encourage creative forms of expression in using math (e.g., combining art or even opportunities for civic engagement with math lessons).

The fourth characteristic of culturally responsive teaching posits empowerment and building students' sense of competence in numerous avenues that are meaningful to them. The goal for students should not only be to gain proficient or advanced levels of performance, but to foster their motivation, enjoyment, and positive self-perceptions (Gay, 2000; 2015; 2018). Math teachers can do this through extending opportunities for individual and/or group-oriented academic support, and offering activities or projects outside of formative, evaluative tests.

The fifth component of what culturally responsive teaching encompasses describes practices that aim to employ social justice beliefs and actions to transform students' educational outcomes. This involves teachers critiquing and resisting "…conventions of traditional educational practices..." that marginalize students whose communities have had to overcome oppression (Gay, 2018, p. 41). Similar to what was mentioned before, math teachers create a transformative experience through having high expectations for students and not solely attributing their overall success to evaluative scores, offering diverse perspectives, and connecting math lessons to real life.

The next and sixth component is prioritizing and fortifying students' intellectual liberty. This strives to nurture students' confidence to show them that they can make a difference in their society (Gay, 2013). Validating students' backgrounds through math lessons and providing a collective space that fosters the appreciation of several perspectives encourages students to believe that they are important agents of their learning, and to the world around them.

The seventh component includes humanizing students. Overall, the descriptions of the aforementioned characteristics such as having high expectations, forming a collaborative environment, validating and affirming their backgrounds, and being responsive to their interests and needs, all lead to recognizing students' humanity. Therefore, in the math classroom, bringing in culture, lived experiences, and appreciating students' creativity and input reveals their humanity, and does not bind their importance to test scores or performance.

Lastly, teachers acknowledging that a culturally responsive approach to teaching and learning is vital is the final component that characterizes culturally responsive teaching. Putting culturally responsive teaching into practice is necessary for ensuring students' wellbeing and positive development; students who feel seen, heard, understood, and can take on and acknowledge others' perspectives will benefit academically and socially (Barnes, 2019). For math teachers, the entire process of embodying cultural responsiveness is contingent on their own beliefs and buy-in about it being effective for students. Teachers' buy-in guides the practice of culturally responsive teaching, and in turn should facilitate students' academic success (Barnes & McCallops, 2019).

The Bio-ecological systems theory

Bio-ecological systems theory (Bronfenbrenner, 1979; 1994; 1999; 2005) enhances the ideas set forth by culturally responsive teaching (Gay, 2000; 2018) by explicating how society, the educational system, those involved in decision-making about education, and interpersonal interactions at school collectively affect students' social and academic outcomes. The notion of proximal processes is the primary proposition of bio-ecological systems theory. Proximal processes describe the daily, consistent activities and interactions that an individual experiences and facilitates (Bronfenbrenner & Morris, 2006; Rosa & Tudge, 2013). For students in traditional public school, proximal processes include frequent interactions with teachers, peers, and staff at school. It also includes their involvement in sports, or any patterns or routines that shape their academic experiences. Since proximal processes occur consistently, they leave a lasting impression to students as they grow and develop. For adolescent students, a positive relationship with teachers foresees better relationships with classroom peers, other teachers, improved engagement, persistence, interest in school, and postsecondary aspirations (Camacho et al., 2017; Perez-Felkner, 2015; Smetana et al., 2006). Additionally, having positive interactions with teachers can help students feel that they have adult support systems, which are protective and beneficial to their social and emotional health (Perez-Felkner, 2015; Smetana et al., 2006).

Bio-ecological systems theory posits that proximal processes are sensitive to individual differences in personality, biology, and behavior, and that their influence depends on contextual and chronological factors (Bronfenbrenner & Ceci, 1994; Bronfenbrenner, 2005). Bronfenbrenner and Morris (2006) devised the process, person, context, and time (PPCT) model to explain the course of proximal processes. Process refers to proximal processes, and to understand how process works, the person component of the model should be described. Person is defined by all the characteristics (e.g., physical, biological, personality, age, spoken language) that makes up an individual. The person's characteristics are shaped by/ and influence their proximal processes (Bronfenbrenner & Ceci, 1994). For example, if a teacher does not share nor have experience with a particular student's cultural background, interests, or ways of knowing, then there may be a cultural disconnect where confusion and differential treatment may emerge (Carey et al., 2018a). The context aspect of the PPCT model describes how person and process functions as a result of interconnected systems (Bronfenbrenner, 2005; Bronfenbrenner & Morris, 2006).

The series of interconnected systems that comprise the context aspect of the PPCT model include microsystems, mesosystems, exosystems, and macrosystems (Bronfenbrenner & Morris, 2006). Microsystems are the most influential since they are the immediate environment the individual interacts in, or where proximal processes occur (Bronfenbrenner, 1994, p. 39). Pertinent to academic experiences in math, the classroom setting is an example of a microsystem. The classroom is an immediate environment where students build and maintain interactions with others on a consistent basis (i.e., proximal processes). Next, the mesosystem symbolizes the exchange between the other persons/objects present in several microsystems (p. 40). The mesosystem can include other classrooms or settings with different teachers, other adults, subjects, and peers. This is a series of interconnected microsystems, and as such, students' own experiences, and their interactions with others in more than one context within their school setting are their mesosystem.

Although the microsystem and mesosystem involve tangible and accessible contexts, the exosystem is indirect, and the person is not present within this system. Rather, the processes and decisions that occur here affect the person's micro and mesosystems (p. 40). Examples of this in an educational context includes school district policies, standards, and professional learning opportunities for teachers. These factors affect the ways that teachers implement instruction, which then can influence the microsystem and system of classroom communities at a school (e.g., mesosystem).

The macrosystem is the outermost layer of each interconnected system in the bio-ecological contextual model (Bronfenbrenner, 1994, p. 40; Bronfenbrenner, 1979). It can be made up of cultural beliefs, symbols, values, governing ideologies, and laws that permeate into the exosystem, mesosystem, and microsystem. In the United States, its history and cultural values and beliefs tracing back to colonialism is rooted in racism, heteronormativity, and ableism (Annamma, 2013; Pérez Huber & Solórzano, 2015). These values and beliefs pervaded throughout history, often showing its prevalence through economic, racial, and gender inequities, such as those disparities in education, like differences in mathematics performance that affect girls, youth of color, neurodivergent youth, and immigrant youth (Annamma, 2013; Dixson & Anderson, 2017; Riegle-Crumb, 2006; Young & Cunningham, 2021).

Lastly, the time component of the PPCT model, also known as the chronosystem, influences all of the aforementioned systems (Bronfenbrenner, 1999). Time involves microtime, mesotime, and macrotime (Bronfenbrenner & Morris, 2006). Microtime considers a proximal process that happens during a specific activity. This includes being present during a classroom lesson, participating in a classroom activity, or any classroom interaction with the teacher or peers. Mesotime considers the frequency and duration of such proximal processes, such as whether certain classroom lessons, activities, and interactions are routine over several days or weeks.

Macrotime refers to generational patterns or shifts in traditions that are contingent on societal, technological, and economic circumstances (Bronfenbrenner & Morris, 2006). The macrotime, however, is speculative, in the sense that it varies with the generation students develop in (Bronfenbrenner, 1999; Rosa & Tudge, 2013). I will consider the impact that the COVID-19 pandemic has had on middle and high school students' math classroom format during which lessons and interactions with teachers took place in a mixture of virtual and physical spaces.

Rationale for Theoretical Frameworks

This study is bound to students' traditional public school system and examines how aspects of culturally responsive teaching functions within it. This study postulates that culturally responsive teaching occurs in the microsystem (i.e., the math classroom), and it transcends to influence their mesosystem (i.e., social relationships with others at school outside of the math classroom). Culturally responsive teaching at the microsystem and mesosystem level may influence and be influenced by the person (i.e., student) and their reported engagement in math class and interpersonal relationships at school. Next, the magnitude of students' experiences with culturally responsive teaching could be explained by individuals in the exosystem who are involved in organizing teacher professional learning and providing resources for culturally responsive teaching. Furthermore, the range in which culturally responsive teaching happens is also a byproduct of the societal and overall cultural context that the aforementioned systems are embedded in, also known as the macrosystem.

Likewise, another important determinant is the developmental and generational period of students in this study, which is the chronosystem. In this study, students experienced disruptions and changes to their classroom format due to COVID-19. This is an important aspect of their chronosystem that I consider.

Overall, culturally responsive teaching (Gay, 2000; 2018) specifies how the inclusion of cultural symbols, conversations and activities around race, ethnicity, sex, gender, class, and other personal attributes in academic instruction can shape the ways in which students reflect on their identities, learn new skills and ideas, and interact with others. This study examines outcomes related to culturally responsive teaching and integrates a bio-ecological systems framework to afford a far-reaching analysis of how educators "fit into the individual and collective learning ecologies of students and the ways that students from all backgrounds and identities bring assets and liabilities to the learning process" (Renn, 2012, p. 273). Thus, culturally responsive teachers are not the sole drivers of students' learning processes, but students themselves and other contextual factors are equally influential to how they learn and what outcomes emerge. Though culturally responsive teaching asserts that it is beneficial for all students, especially students of color, its outcomes differ based on where students are situated in terms of developmental stage (e.g., age), environment (e.g., geographic location), and personal characteristics, such as race, language, and gender (Averill et al., 2009; Gay, 2018; Garcia & Chun, 2016). Hence this study aims to build on prior quantitative work on culturally responsive teaching by integrating a developmental analysis of how culturally responsive teaching results in math engagement and interpersonal relationships.

Chapter 3

LITERATURE REVIEW

Adolescent Development in Middle School and High School

This study draws from the perspectives of middle and high school students, and these students are in the developmental period of adolescence. Adolescence is typically characterized into three phases: early, middle, and late (Neinstein et al., 2009). During early adolescence, which is distinguished by the onset of puberty, students experience a multitude of changes to their cognitive, social, and emotional development (Wigfield et al., 2006). First, at the early adolescent stage, students gain the cognitive capacity to think in critical and abstract ways, and this is essential for learning and doing mathematics (Dahl et al., 2018; Piaget & Inhelder, 2000). Critical and abstract thinking becomes more intricate throughout the course of early to late adolescence given the educational, cultural, and social opportunities presented to students (Crone & Fuligni, 2020; Killen & Smetana, 2010).

Students in early and middle adolescence acquire numerous experiences within the realm of social relationships. They begin to gain more independence from adults and become focused on building their social networks with peers (Crone & Fuligni, 2020; Wigfield et al., 2006). This focus on peer relationships is most prominent in early adolescence, and this has implications for their academic outcomes, with peers often being prominent influences in student's engagement and interest in school (Dahl et al., 2018; Wentzel & Watkins, 2002).

Early adolescents gain more autonomy from social relationships with adults and center their attention towards fitting in within groups of peers (Simmons & Blyth, 2017). Researchers have noted that academic performance, especially in subjects like mathematics, often decreases for middle school students in the United States as a result of rapid social and psychological changes that occur during middle school (Rockoff & Lockwood, 2010; West & Schwerdt, 2012). However, scholars find that middle school students of color, those from lower socioeconomic status, and those with disabilities are especially prone to underperforming in math (Alliman-Brisset & Turner, 2010; Lambert, 2015). The reasons behind such underperformance in math include unfair treatment from peers, teachers, and others involved in their education, and inequities in resources for learning, such as those that involve using economically inaccessible materials (Johnson et al., 2021; Lambert & Tan, 2016; Nasir et al., 2017; Rogers et al., 2020; Walker, 2009).

Like in middle school, peer relationships are also critical to high school students' psychological, social, and academic welfare, yet these students experience high levels of stress related to meeting more elaborate academic standards and planning for their future (Battey, 2013). Nevertheless, struggles due to socioeconomic status, discrimination, and/or having fewer academic support systems or resources further impedes high school students' academic performance, interest, and aspirations (Battey, 2013; Irizarry, 2021; Rogers et al., 2020). For many students in middle school and high school, positive social relationships with peers and adults at school benefits their academic engagement and performance (Barbieri & Cotto, 2021; Zander et al., 2019). In fact, Williams and Davis (2021) found that peers' and school staff's support, such as showing care and encouragement, played a significant role in math performance for Black and Latinx high school students. Culturally responsive teaching is a way to nurture these relationships.

Catalysts of Culturally Responsive Teaching

Prior to discussing existing literature around student perceptions of culturally responsive teaching, it is helpful to understand factors at the exosystem bio-ecological systems level that promote teachers' use of culturally responsive teaching practices. Culturally responsive teaching involves students being actively engaged in lessons, critically aware of social and political issues, and involved with their communities and families (Farinde-Wu et al., 2017). Teachers who may not have the resources or support to fully implement culturally responsive teaching could miss essential components of culturally responsive teaching. For teachers, culturally responsive teaching requires familiarity with the population of students they serve, and importantly, self-reflecting on personal beliefs and potential biases (Gay, 2013). Without support from their fellow teachers or administration, teachers may mistakenly incorporate counterproductive culturally responsive practices, such as incorporating cultural representation in ways that displays cultures as uniform and identical rather than distinctive (Battey & Leyva, 2018; Brown et al., 2019; Carey et al., 2018b; Sleeter, 2012; Young, 2010). Including cultural representation in lessons must involve deep critical analysis of the social world that students know (Brown et al., 2019; Farinde-Wu et al., 2017; Gutiérrez, 2013; Gutstein, 2016; Yeh & Otis, 2019).

Much of the literature on culturally responsive teaching has assessed teachers' perspectives, such as their beliefs, confidence, and implementation (Sleeter & Owuor, 2012). Teachers' experiences with culturally responsive teaching are contingent on systems that facilitate their abilities and confidence to relate to their students and affirm their backgrounds (Gay, 2018). Teachers benefit from professional learning that encourages culturally responsive teaching, collaboration with peers, and curricula and materials that facilitate this method of teaching (Young, 2010). Yet this has been a challenge in a society that prioritizes teaching for standardized testing and demonizes teachers for mentioning cultural, politics, or social justice issues to their students (Gutiérrez, 2013). The following sections summarize literature related to middle and high school students' microsystem perspectives of experiencing culturally responsive teaching in math class.

Student Perceptions of Culturally Responsive Teaching in Mathematics

In quantitative research, students' self-reported experiences with culturally responsive teaching in middle and high school mathematics is an understudied phenomenon. Studies assessing middle and high school students' experiences in mathematics have used culturally relevant pedagogy as a framework (see Ladson-Billings, 1995; Hubert, 2014), which has similarities with culturally responsive teaching. Studies that have explored culturally relevant pedagogy in adolescent populations show results that may provide evidence of culturally responsive teaching in mathematics having an association with positive social and academic outcomes (Byrd, 2016; Gutstein, 2016; Hubert, 2014).

Teaching practices that align with culturally responsive teaching provide advantages to students' social and academic wellbeing. Students who receive culturally responsive teaching perceive higher expectations from teachers and more confidence in their academic abilities (Thomas & Berry, 2019; Garcia & Chun, 2016). Hubert's (2014) qualitative case-study on African American high school students' experiences with a mathematics teacher whose beliefs embodied culturally relevant pedagogy found that students felt more engaged during instruction delivery, more connected to classroom peers, comfortable with their teacher, and more confident in their ability to do math. While not specific to math class, another study by Byrd (2016) that used culturally relevant pedagogy as a lens of inquiry found that racially and ethnically diverse adolescent students in middle and high school reported more positive social relationships with peers of different races and ethnicities, more interest in going to school, and increased feelings of belonging at school as a result of their teachers delivering instruction in ways that hold them to higher expectations, promote social justice and leverage their lived experiences. Given the evidence seen with studies of culturally relevant pedagogy, it is likely that such positive outcomes hold true with culturally responsive teaching in the mathematics classroom.

Gutstein's (2016) auto ethnography of a teaching approach that is consistent with the theory of culturally responsive teaching allows for understanding how positive student outcomes could emerge. In his mathematics high school classroom with a predominant population of Latinx and African American students, he employed a teaching method that he termed “Reading and Writing the World With Mathematics.” Gutstein (2016) aimed for algebraic concepts to be meaningful and applicable to students’ lives by connecting ideas to history, and by demonstrating how concepts can be used to transform their society. For example, while teaching concepts around graphing, Gutstein (2016) encouraged students to apply their knowledge of graphs with projects where they first traced their families’ history in their neighborhood community, and then used that information to create a graphical visual of how their history relates to housing, income demographics, and discrimination at a systemic level. The students in his classroom had strong performance in the subject and displayed higher levels of participation, collaboration, and interest. In all, Gutstein’s (2016) study exhibited how culturally responsive teaching could positively contribute to deeper mathematics learning, and potentially students’ social interactions with others and engagement in the subject.

Definitions of social and academic outcomes

Engagement

In this study, engagement serves as an outcome from experiencing the process of culturally responsive teaching in the math classroom, which is the microsystem. The construct of academic engagement consists of behavioral, affective, and cognitive elements (Appleton et al., 2008; Fredricks et al., 2004). Behavioral engagement is students' displays of paying attention, their active participation, and the extent to which they remain on task during lessons and activities (Fredericks et al., 2004; Furlong et al., 2003). Affective engagement refers to students feeling enjoyment, satisfaction, and interest, whereas cognitive engagement involves students feeling immersed in a subject and devising ways to deepen their knowledge (Fredericks et al., 2004; Furlong et al., 2003). For the purposes of this study, dimensions of affective and behavioral engagement serve as outcomes of culturally responsive teaching.

Interpersonal relationships

Interpersonal relationships is a multidimensional construct. Here, it is an outcome for the mesosystem, or system of classrooms in school where students may have different relationships and interactions with peers and adults. Generally, interpersonal relationships are interactions between people that result from consistent communication (Zandvliet et al., 2014). I define interpersonal relationships as displays of caring, supportive, and consistent interactions between students and peers at school, between students and classroom teachers, and between students and other adults who are not necessarily teaching staff but interact with them in school.

Chapter 4

RESEARCH QUESTIONS

Using a sample of 186 middle school and high school students from one school district in the United States, this study investigates their mathematics engagement and social outcomes, and how culturally responsive teaching facilitates these variables. The research questions that guide this study takes up aspects of the PPCT model from bio-ecological systems theory. I seek to answer three research questions:

1. Research question 1: The microsystem: After accounting for middle or high school level, and the format in which students attended class (i.e., online or in-person), does culturally responsive teaching in math class predict students' self-reported engagement in math?
2. Research question 2: The mesosystem: After accounting for middle or high school level and the format in which students attended class (i.e., online or in-person), what is the association between students' reports of culturally responsive teaching in math class and their interpersonal relationships with peers and adults at school?
3. Research question 3: The exosystem: What were the culturally responsive teaching goals, strategies, and expectations of educational stakeholders (curriculum and professional learning providers)?

Significance of the present study

This study demonstrates that the effects of culturally responsive teaching in students' classroom context is best understood through the lens of bio-ecological systems. It is not the sole responsibility of one teacher, but several systems, to successfully implement culturally responsive teaching practices. In addition, the person component of bio-ecological systems displays how culturally responsive teaching involves an exchange between student and teacher, signifying that student characteristics are instrumental variables to be considered when examining and devising its implementation. This study also uses components of QuantCrit to provide a rich, contextual basis of how oppressive practices at the macrosystem level can affect the extent to which cultural responsiveness emerges in students' immediate environments in school.

Chapter 5

METHODS

Overview of Research Design

This study involves a correlational design utilizing cross-sectional survey data (Creswell, 2009). Data collection took place during the spring of the 2021 school year, when many students in the United States attended classes either virtually, in-person, or a mixture of both due to the restrictions posed by the COVID-19 pandemic. The students in this study completed self-report questionnaires asking about their experiences in their mathematics class and their broader experiences at school. The educational stakeholders in this study were leaders involved in a Professional Learning Partnerships (PLPs) research study, and they reported on their beliefs and goals about culturally responsive teaching.

The Bill & Melinda Gates Foundation funded the 12 PLPs as part of an initiative to improve teacher professional opportunities and educational outcomes for adolescent students who come from communities that have overcome marginalization. The students in this study were part of one PLP that consisted of a network of schools in one district (e.g., four middle schools and four high schools) who joined a research partnership with a curriculum developer and consultants. Their coalition aimed to transform professional learning for teachers who served student populations that are racially and ethnically diverse, emerging bilinguals, and of lower socioeconomic status.

Research Paradigm

A paradigm broadly refers to a researcher's dispositions of how to inquire about a specific phenomenon (Kuhn, 1970). Within a paradigm, researchers formulate inquiries via their ontology (i.e., beliefs about how phenomena come to existence), epistemology (i.e., how answering questions about a phenomena should be approached and interpreted), and methodology (i.e., how knowledge about a phenomena will be obtained) that resonates with them (Gray, 2013). Quantitative work is traditionally aligned with postpositivist epistemic commitments and contends that phenomena can be studied objectively, but it is subject to probability (Creswell, 2009; Gray, 2013). In contrast to the postpositivist epistemological belief that human phenomena can be studied without bias, I interpret results for this study using tenets aligned to QuantCrit. Critical race theories guided the development of QuantCrit (Ladson- Billings, 1998; Lynn et al., 2002; Solórzano & Yosso, 2002; Suzuki et al., 2021). The five tenets (see Garcia et al., 2018; Gillborn et al., 2018) of QuantCrit state the following:

1. Racism and discrimination are central variables to making predictions or inferences about inequities in education;
2. Any numerical representation of data are not neutral, nor do they solely provide factual representations of individuals' lived experiences;
3. Assigning individuals to categories (e.g., race, gender, etc.) involves ideas that are socially constructed, which inevitably restricts the breadth of inferences made;

4. Any conclusions made about data or findings must involve efforts that leverage the voices and experiences of individuals whose communities have worked to challenge their oppression;

5. Researchers should possess goals of using numbers for social justice, such as by highlighting how data disaggregation and counternarratives could be used to expose oppressive practices.

In sum, QuantCrit challenges paradigms that relegate the role of institutional racism and discrimination, and data must be presented and analyzed with the intention of exploring the role that power, social, and political forces have on hypothesized outcomes (Garcia et al., 2018; Pérez Huber et al., 2018). In the discussion portion of this study, I utilize QuantCrit to explain how oppressive structural forces in the macrosystem (as posed by bio-ecological theory; Bronfenbrenner & Morris, 2006) may influence measured outcomes. I also consider my positionality, which allows researchers to situate themselves within the context of their study and reflect on how their experiences and dispositions shape their methodology and inferences (Alcoff, 1988).

Positionality

QuantCrit scholars reject the notion of neutrality that is prevalent in much quantitative research (Garcia et al., 2018; Gillborn et al., 2018; Suzuki et al., 2021). For that reason, I reflect on and recognize how my own background, beliefs, and privileges can affect the ways in which I approach my methods and conclusions (Milner, 2007).

I arrive at this topic as the daughter of immigrants from the Dominican Republic who came to the United States seeking improved labor conditions. My mother worked in housekeeping and childcare, while my father worked as a taxi driver. My parents did not obtain more than the equivalent of a high school degree and were unfamiliar with the logistics of the postsecondary education system of the United States. However, they cultivated a supportive home environment that prioritized my academic attainment. They provided me with advice and encouragement to go to school and find a career that I would be passionate in pursuing. For my family, excelling in academics was the only way to escape unfavorable, low socioeconomic working conditions. My parents' constant encouragement and support contributed to my success as a graduate student in Human Development and Family Sciences. Likewise, their emphasis on finding a career that involves passion drove me towards educational research with adolescent students.

The scope of work I proposed in this study is personal to me, as my adolescent years were sensitive to ascribing to the culture of the United States in order to feel accepted. Much of the academic instruction I received overlooked my position as a first generation Dominican American/ Afro Latina. In fact, math was my least preferred subject. I rarely saw cultural representations of people like me using math, and I perceived it as a mundane subject. While I had numerous influential and admirable teachers, I struggled in math throughout middle school and high school partly due to my disinterest. My attitude towards math shifted after attending college as an undergraduate in Psychology, as this is when I discovered the notion of being culturally competent and responsive. In college, I also grew passionate about school-based and educational research because it presented an opportunity to leverage the experiences of students like me. Therefore, I take up topics such as culturally responsive teaching and bio-ecological systems to understand how a students' academic and social functioning unfolds in a system that affirms their cultural backgrounds, home lives, experiences, and so forth.

In conducting this study, I acknowledge that I am privileged as a graduate student who works alongside well-lauded scholars. My position as a graduate student affords me privileges that the sample in my study may not have. Nevertheless, I draw from my prior experiences as an Afro Latina navigating the public school system to carefully disseminate students' perspectives collected for this study.

Data Sources

I, along with a group of 14 researchers assessing the 12 PLPs, collected survey data from students and PLP leaders as part of a 3-year longitudinal evaluation study funded by the Bill & Melinda Gates Foundation. Each of the 12 PLPs distinctly focused on curricular-aligned professional learning on one subject: mathematics (*n*=10), science (*n*=1), or English Language Arts (ELA; *n*=1). We obtained student survey data from one PLP whose initiative focused on mathematics. Our survey data for student self-reports was cross-sectional, and PLP survey reports were longitudinal.

However, in this study I analyzed: 1) One data point for PLP leaders, 2) An artifact listing their goals and mission; and 3) Students' cross-sectional survey data.

Student Participants

The survey sample included students from four middle schools and four high schools. One hundred and eighty-six students (59 students in middle school and 126 students in high school) participated in the student survey. Publicly available school data indicated that the student population for the four middle schools combined is comprised of 44% Female; 12% Black/African American; 40% Latinx; 16% Asian; 1% Indigenous (Native American, Alaskan Native, Pacific Islander); 21% White; and 10% Two or more races/or not reported. Demographics for the high school population for the four participating high schools consists of 47% Female; 10% Black/African American; 44% Latinx; 16% Asian; 1% Indigenous (Native American, Alaskan Native, Pacific Islander); 21% White; and 8% Two or more races/or not reported.

Prior to distributing the student survey, my research team and I conducted cognitive interviews to refine the items. Cognitive interviewing is the process of studying how participants understand and respond to survey items for the purpose of bolstering validity and reliability (Desimone & Le Floch, 2004; Ryan et al., 2012). In addition to compiling the survey questions, we developed a cognitive interview protocol to probe for understanding and clarity of each survey item (Ryan et al., 2012). The only criteria to participate in the cognitive interview was that the respondent was a middle school student, as this was representative of our intended survey participants.

We used a snowball sampling method to recruit local participants for cognitive interviews, with students being asked to refer friends or family that fit our criteria of middle school going students. A series of eight interviewees participated in cognitive interviews: Four students ranging from 5th to 7th grade (3 boys, 1 girl identified as Latino/a (Ecuadorian or Dominican), and attended public schools located in urban, lower socioeconomic areas; three students identified as White/Caucasian and attended public or private schools in socioeconomically diverse suburban and urban areas; 1 student identified as Asian, and attended a public school in a socioeconomically diverse suburban area. Throughout the cognitive interview process, students' responses about items' clarity and language appropriateness drove the modifications made to survey items. We modified the survey based on students' feedback and adjusted it to ensure that it could be completed within a five-minute span, as this was the time allotted for student data collection.

Beginning in the spring of 2021 (early through mid-March), the school district in the PLP and its administrators granted permission to distribute surveys to students via Qualtrics, a web-based data collection platform. We obtained exemption from the Institutional Review Board to proceed without parental consent for students' participation. Students provided their assent prior to beginning the survey.

Survey data collection began in early April of 2021 through the end of the 2021 school year in June. Administrators from the PLP's district collaborated with us to provide classroom teachers with an anonymous student survey link in Qualtrics. The anonymous link facilitated data collection without any identifying or confidential information about students. After being provided with the anonymous link, the teachers administered the survey during class. We incentivized students who provided assent and participated in the survey with a $10 gift card.

PLP Leader Participants

The larger study of the 12 PLPs investigated what mechanisms or practices within their initiatives led to changes in teachers' professional learning experiences, curriculum adoption, instruction, and student outcomes. Leaders from the PLPs who consented to our data collection efforts completed a series of three surveys throughout the course of our 3-year study. In this present study, the survey data source for the PLP leaders came from the final round of data collection (in Spring 2021). This survey data illustrated their emphasis on preparing teachers for culturally responsive teaching. In addition to the PLP leader survey, I analyzed a written artifact – specifically their submitted grant proposal, where the PLP documented culturally responsive goals for teachers and students.

Three leaders from the partnership participated in the survey. Two leaders were affiliated with the district, and another represented the professional learning and curriculum provider. PLP leaders did not report demographic data concerning race/ethnicity, or gender.

Data Collection

Students responded to a short 5 to 10 minute survey on Qualtrics that measured their perceptions of culturally responsive teaching in math class, engagement, and interpersonal relationships at school. Students also responded to questions about their schooling arrangements during the academic year, or whether they experienced instruction virtually, in person, or both. Similarly, on Qualtrics, PLP leaders completed a 35 to 40 minute survey about their organizational goals and their initiative. They also provided a grant proposal document for further analyses of their goals. In our data collection procedures, we did not ask the 186 students who completed the survey for information about their race, ethnicity, gender, and age due to district concerns of confidentiality.

Survey Measures

Engagement

My research team and I assessed for engagement in math class using four items adapted from several sources, such as The School District of Philadelphia Teacher Survey, Chicago 2020 5Essentials Student Survey Engagement Scale, and the NYC School Survey 2020. These items are consistent with the definitions of behavioral and affective engagement. Students rated the extent to which they engaged in class on a 4-point frequency scale, *Never*, *Once in a while*, *Some of the time*, *Most or all of the time*. Items included, "ask your teacher questions when you need help" for behavioral engagement, and "feel bored" for affective engagement. The items in this scale yielded reasonable reliability, α=.64.

Interpersonal Relationships

We measured interpersonal relationships using items from three sources: the Chicago 2020 5Essentials Student survey, the Delaware School Climate survey (Bear et al., 2011), and Tovar et al.'s (2009) college mattering scale. Students rated on a 3-point scale of *0-Strongly disagree, 1-Disagree, 2-Agree, and 3-Strongly agree* prompts such as "My teachers treat me with respect," (Chicago 2020 5Essentials Student survey), "I get along well with students from my school," (Bear et al., 2011), and "There are adults from my school who care about me as a person" (Tovar et al., 2009). This scale indicated a reliability of α=.73.

Culturally Responsive Teaching

We developed a scale to measure students' perceptions of their mathematics teacher's culturally responsive teaching with four items. The school district allotted our team 5 to 10 minutes for student survey data collection, and therefore we created a short scale to capture the general propositions of culturally responsive teaching. One item was adopted from a previously validated scale, the NYC School Survey 2020, and we construed remaining items using the theoretical framework set forth by Gay (2018). Students responded to the prompt, "How often does your math teacher do each of the following?" and rated the items "My math teacher has us discuss social or political issues for example: equal rights, poverty, the environment, voting, or health care;" My math teacher has us do projects that relate to social or political issues for example: equal rights, poverty, the environment, voting, or health care; "My math teacher uses examples of students' different cultures/backgrounds/families in their lessons;" and, My math teacher respects my culture and background" on a 3-point frequency scale (*0-Never, 1-Once in a while, 2-Some of the time,* and *3-Most of the time*). These items yielded good reliability, α=.74.

We also measured PLP leaders' perceptions of the extent to which culturally responsive teaching is emphasized in their planning towards teachers' professional learning. PLP leaders responded to 18 items using a rating scale where 0-*Not at all, 1-To a small extent, 2-To a moderate extent, 3-To a great extent, and 4- I don't know.* They were prompted to answer each item with the question, "In professional learning activities, either those you have planned or those you have enacted, to what extent does your PLP emphasize the importance of having teachers engage in each of the following?" Items included, "Using students' cultural background to help make learning meaningful;" and "Using examples of the cultural, historic, and everyday lived experiences of students during instruction." Reliability analysis of responses on this survey across all 12 PLPs, rather than solely the one assessed in this study, yielded a high Cronbach's alpha, α=.83.

Data Analysis

I conducted all analyses on SPSS 27.0. Prior to conducting analyses for the student survey data, I ran descriptive statistics to obtain information about scale score means and item frequencies in students' reports of culturally responsive teaching, engagement, and interpersonal relationships at school. For the first research question concerning the effect that students' reported culturally responsive teaching in their math class has on their engagement, I conducted a linear regression. Next, for the second research question I also ran a linear regression to determine if there is an association between culturally responsive teaching in mathematics class and students' interpersonal relationships with others at school.

In the regression models for research questions 1 and 2, I controlled for students' grade level (middle school or high school) and instructional status, which is whether they attended school fully in-person or online. These control variables were dummy coded: for grade level, a zero indicated middle school, and a one indicated high school; for instructional mode, a zero indicated online or hybrid status (e.g., alternating between online and in-person instruction), and a one indicated in-person status. Dummy coding these control variables was helpful in assessing for independent differences between each level of the variable and outcome (Keith, 2019). Additional procedures prior to conducting linear regression also entailed regression diagnostics, where assumptions of linearity, homoscedasticity, independence, and normality must be met. I assessed for these diagnostics and students' survey data met all of the aforementioned assumptions required.

For the final research question concerning what the culturally responsive teaching goals of PLPs were, I examined how frequently PLP stakeholders reported emphasizing culturally responsive teaching in their work using two sources of information. First, I compiled descriptive information (i.e., frequencies) from survey items. Second, I examined what strategies and expectations they underscored in their grant proposal for supporting culturally responsive teaching.

Limitations and Threats to Validity

This study's survey component posed a few limitations. Because of the nature of study utilizing newly constructed scales and the online format in which the survey was distributed, there were threats to construct validity, social desirability bias, and selection bias (Burstein et al., 1995; Fowler, 1995; Ryan et al., 2012). Nonetheless, important components of establishing validity and reliability in surveys involves researchers and participants collectively understanding the meaning of survey questions, and participants having appropriate choices and context in responding to questions (Fowler, 1995). My research team addressed such threats to construct validity using cognitive interviews with students who represented our intended survey sample (Fowler, 1995; Ryan et al., 2012). Survey items also came from previously validated questionnaires. Likewise, social desirability bias (Burstein et al., 1995), or responding in a way that is perceived as socially acceptable, posed a limitation. We asked students to respond to questions about their teacher, and asked PLP leaders to report on their goals. However, students and PLP leaders were assured that responses would be anonymous, since this may preempt responses that are socially desirable (Joinson, 1999). Lastly, selection bias may have been an inevitable factor in this study. It is possible that data collection may have only captured a small subset of students and excluded another who could have also had insightful experiences to report on (Esbensen et al., 2008).

I recognize that the influence of COVID-19 on culturally responsive teaching instruction in math is informative for describing the chronosystem in the bio-ecological systems model but may not generalize to other research in the future. Although this study does not use specific demographics about students who were surveyed, I describe the larger demographics of the district and its schools. A lack of demographic information is a major limitation, especially for QuantCrit, but in discussing results, I make inferences about how cultural beliefs and norms inform students' classroom learning.

Chapter 6

RESULTS

Student Survey Descriptives

Descriptive information regarding students' instructional mode and grade level are shown in Table 1. Means and standard deviations for students' reports of culturally responsive teaching, engagement, and interpersonal relationships are shown in Table 2. For culturally responsive teaching, the scale ranged from 0-*Never* to 3-*Most or all of the time*. The item with the highest frequencies of 3-*Most or all of the time* selected was "my teacher respects my culture and background" (*n*=168). The item with the highest frequencies of 0-*Never* was "my math teacher has us do projects that relate to social or political issues" (*n*=106). Frequencies for the culturally responsive teaching scale items are shown in Figure 1.

Table 1 Student Descriptives

Variable	Percent
Online or Hybrid Instructional Mode	70%
In-Person Instructional Mode	30%
Middle School	32%
High School	68%

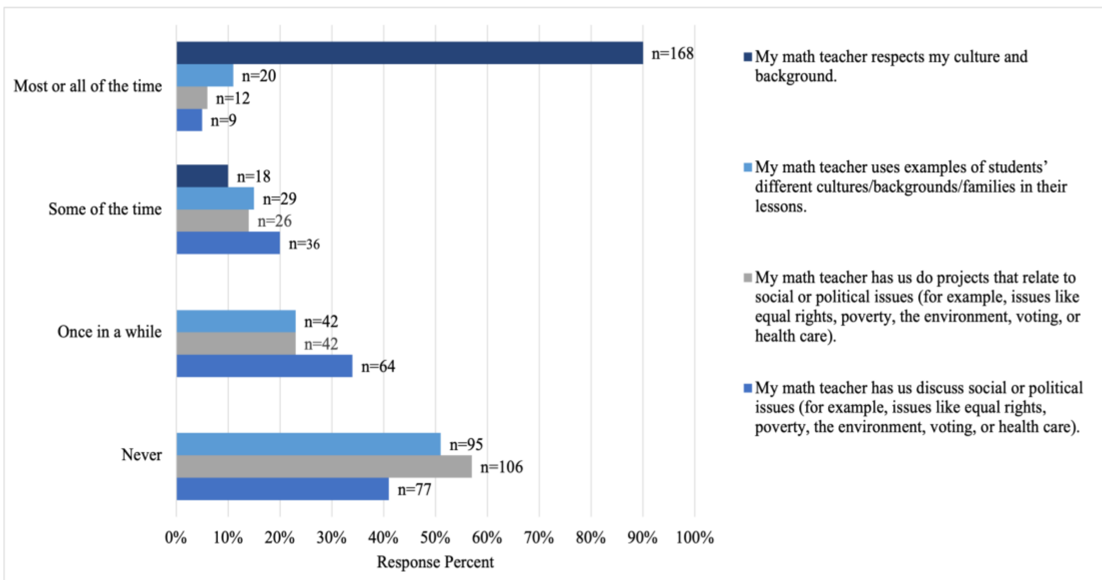
Note: *n*=186.

Table 2 Student Survey Scale Descriptives

Scale	Mean	Standard Deviation
Culturally Responsive Teaching	1.33	.63
Math Engagement	2.01	.54
Interpersonal Relationships	2.42	.48

Note: *n*=186.

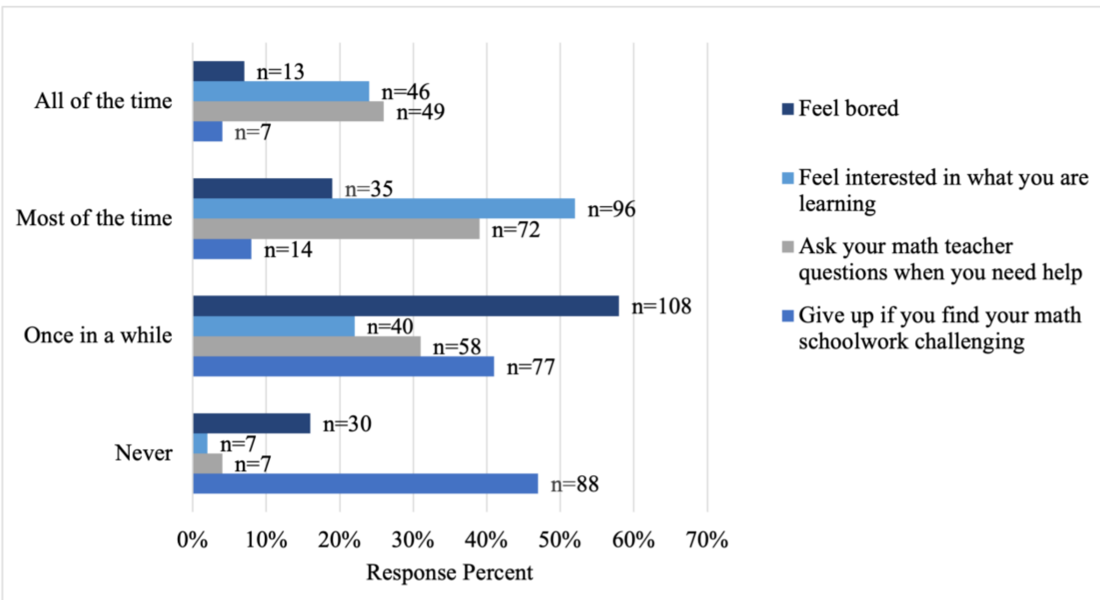
Figure 1 Item frequencies for Culturally Responsive Teaching Scale



Note: *n*=186.

Figure 2 depicts item frequencies for the engagement scale. The response options for this scale ranged from 0-*Never* to 3-*All of the time.* The item most frequently rated 3-*All of the time* was, “ask your math teacher questions when you need help” (*n*=49). The item with the highest frequency of 0-*Never* was, “give up if you find your math schoolwork challenging,” (*n*=88).

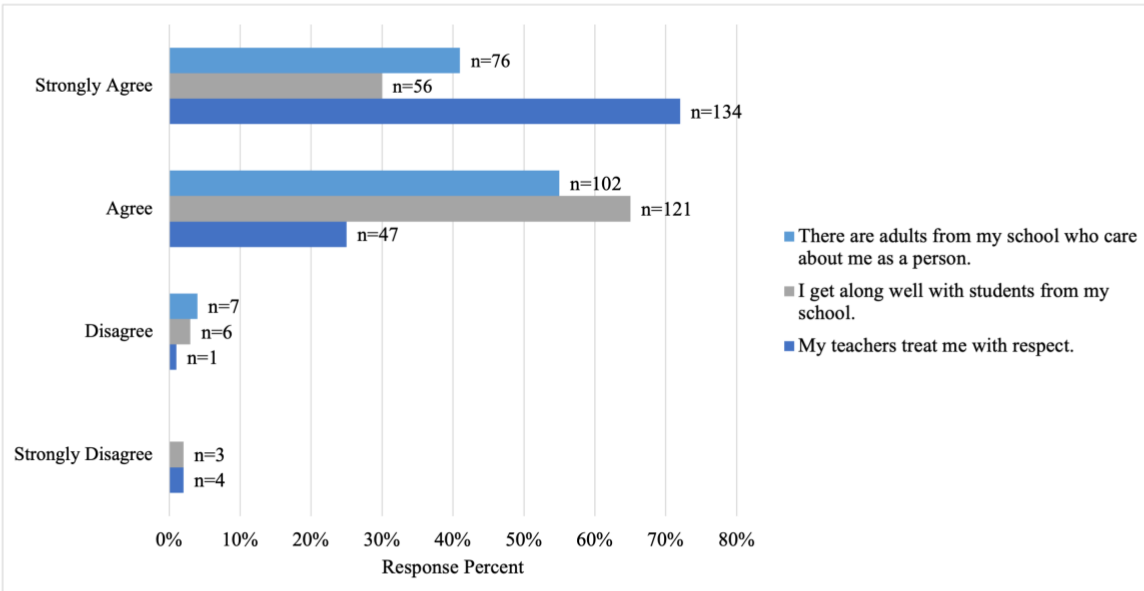
Figure 2 Item frequencies for Math Engagement Scale



Note: *n*=186; stem for items was “In a typical week in your math class, how often do you do each of the following?”

Refer to Figure 3 for item frequencies on the interpersonal relationships scale. The response options for these items ranged from 0-*Strongly Disagree* to 3-*Strongly Agree.* The item with the highest frequencies of 3-*Strongly Agree* was, “my teachers treat me with respect," (*n*=134). Moreover, this item also had the most frequencies of 0-*Strongly Disagree* (*n*=4).

Figure 3 Item frequencies for the Interpersonal Relationships Scale



Note: *n*=186.

Research Question 1

The first research question asked, does culturally responsive teaching in math class predict students' engagement? Results for this regression model are demonstrated in Table 6. The combination of variables accounted for 4.9% of the variance in engagement (*F* [3, 182]=3.09, *MSE*=.89, *p*=.028). This model controlled for the effect of being in middle school or high school (i.e., dummy variable coded as high school) and attending class in-person or online (i.e., dummy variable coded as in-person instruction). After controlling for the aforementioned variables, students' culturally responsive teaching did not significantly predict engagement in math, β= 0.082, *p*=.26. However, the dummy variable of high school did significantly predict engagement in math, indicating that being in high school negatively affected engagement β= -.22, *p*<.01. Contrarily, the additional dummy variable of in-person instruction did not relate to engagement, β= -.12, *p*=.155.

Table 3 Culturally Responsive Teaching's effect on Engagement

Variable	*B*	SE *B*	β
Constant	2.13	.12	
Culturally Responsive Teaching	.07	.06	.08
High School (middle school as reference)	-.26	.09	-.22**
In-person instruction (online as reference)	-.14	.1	-.12

Note: * $p < .05$, ** $p < .01$.

Research Question 2

The second regression model explored whether there was an association between students' reports of culturally responsive teaching in math and their interpersonal relationships with peers and adults at school. Results for research question 2 are demonstrated in Table 7. The combination of variables in this regression was not significant, $R^2 = .025$, $F(3, 182) = 1.56$, *MSE*=.35 *p*=.2.02. Given this finding, it cannot be concluded that students' culturally responsive teaching is associated with interpersonal relationships at school above and beyond the effect of being in middle school/high school and attending class in-person/online.

To address this nonsignificant finding, I conducted a stepwise regression, in which SPSS selects variables that formulate a model with the best predictive ability (Keith, 2019). This analysis resulted in a model consisting of interpersonal relationships regressed on culturally responsive teaching, $R^2 = .021$, $F(1, 184) = 4.02$, $MSE=.89$, $p<.05$. Here, culturally responsive teaching was positively associated with interpersonal relationships at school, $\beta = .15$, $p<.05$.

Table 4 Culturally Responsive Teaching's association with Interpersonal Relationships

Variable	*B*	SE *B*	β
Constant	2.28	.08	
Culturally Responsive Teaching	.11	.06	.15*

Note: * $p < .05$, ** $p < .01$, *** $p < .001$.

Research Question 3

For the third research question, I investigated what the culturally responsive teaching goals, strategies, and expectations of educational stakeholders (curriculum and professional learning providers) were. Analysis of the PLP's emphasis on culturally responsive teaching in the schools that they service consisted of illuminating what they highlighted as aims in their grant proposal, and what they reported in a scale that assessed the extent to which they support teachers to be culturally responsive.

In their 20-page grant proposal, they explicitly mentioned that they concentrated on supporting emerging bilingual students. In general, they conveyed that their schools consisted of predominately Latinx (47%) students, and emerging bilinguals made up 27% of the entire population of the middle and high schools combined. Their goals were the following: to strengthen student engagement in math, improve state-level standardized math test scores for middle and high schools, and bolster college and career outcomes.

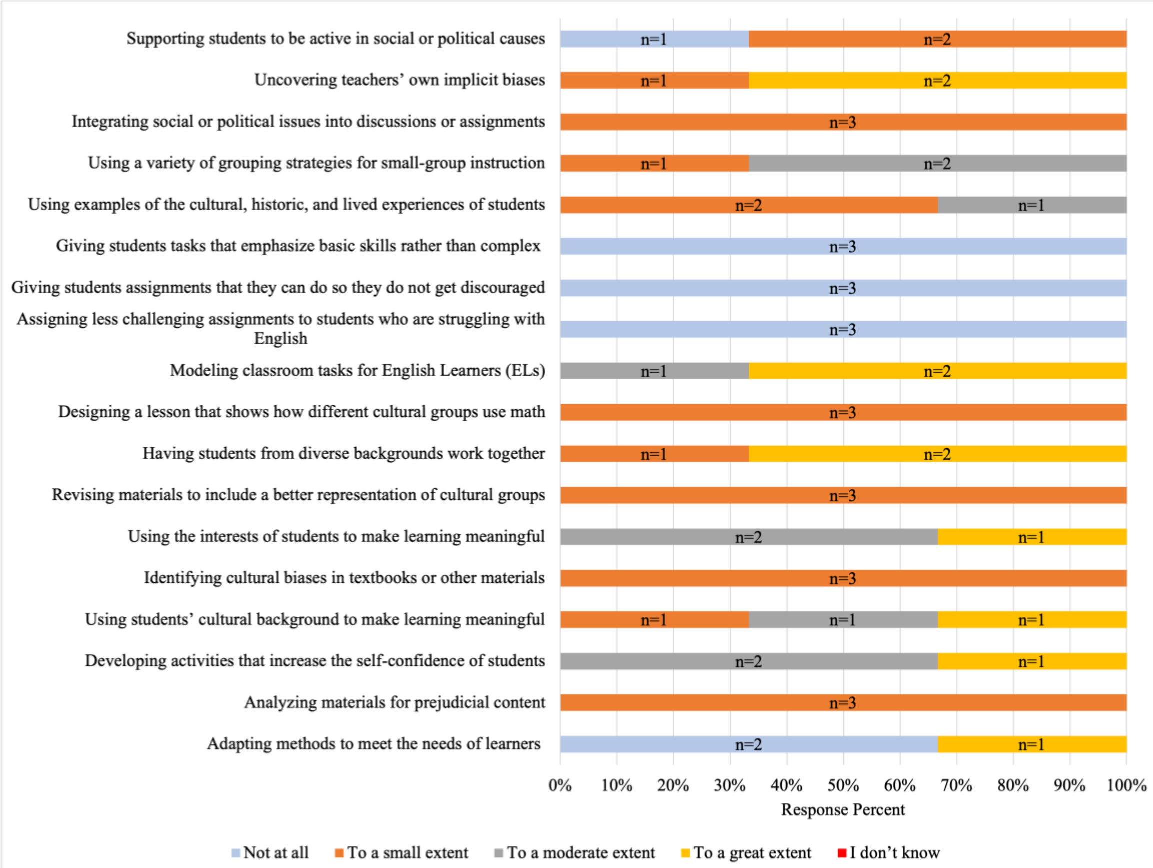
The strategies that the PLP leaders used for achieving such goals included culturally responsive teaching. Specifically, they described that culturally responsive teaching strategies consisted of offering family engagement resources, curricula and lesson plans geared towards acquiring language needed for math, and professional development trainings for teachers that improve their beliefs about working with emerging bilingual students and their instructional practices. Resources that they planned for families included videos and materials that are accessible (i.e., through digital delivery or sending home materials with students), and that are informative in terms of what their role is in their child's math attainment, and what their child is learning in the math classroom. Similarly, they aimed to develop videos and trainings for teachers to support their math language routines for emerging bilinguals. They proposed professional learning resources for guiding teachers' preparation of lesson plans in ways that aligned to their adopted curriculum, which guided culturally responsive practices. Moreover, teacher trainings were also posed as consisting of sessions where teachers collaborated with peers to practice their use of culturally responsive teaching strategies for emerging bilingual students.

Interestingly, the PLP's grant proposal acknowledged that their efforts may not be generalizable to those who have worked to overcome marginalization in the United States. In their proposal, they stated, "we are aware there is not a one-size-fits-all approach for reaching Black, Latino, and low-income students…" They outlined that their partnership had over five years of experience in successfully working with middle and high schools outside of this study's district to develop curricula and professional development for diverse groups of students, including emerging bilingual students. Much of their strategies around culturally responsive teaching were oriented around connecting students' home lives and language to the math classroom. They primarily aimed to fortify teachers' abilities to connect students' lived experiences into lessons.

Survey data provided additional information about the extent to which they supported teachers in culturally responsive teaching. The survey measure evaluated specific components related to Gay's (2018) culturally responsive teaching framework, and aided in understanding whether the PLP's emphasis was tied to its larger theoretical components. Three PLP leads responded to 18 items about how much they emphasize culturally responsive teaching in the schools that they provide professional learning, curricula, and other supports for. The rating scale included options, such as 0-*not at all*, 1-*to a small extent*, 2-*to a moderate extent*, 3-*to a great* *extent,* and 4-*I don't know*. For the overall scale, the three PLP leads' responses revealed a mean of 1.89 and there was no variation in their responses (SD=.00). The PLP leads tended to agree that they emphasized culturally responsive teaching to a small or moderate extent.

Scale item frequencies are shown in Figure 4. Additional item level analyses showed that two out of three PLP leaders responded with 3-*to a great extent* for three items: "having students from diverse backgrounds work together," "modeling classroom tasks for English Learners (ELs)," "uncovering teachers' own implicit biases in their teaching practice." On the contrary, all three PLP leaders rated another three items a 0-*not at all*: "assigning less challenging academic assignments to students who are struggling with English," "giving students assignments that they can do so they do not get discouraged," "giving students tasks that emphasize basic academic skills before having them engage in complex learning tasks." These items have negative valence, meaning that a lower rating does not indicate that something is lacking; instead, it is comparable to positively worded items in that it shows that they are negating something that is negatively worded (Watson, 1992). Therefore, results from these item-level frequencies show that they primarily focus on emerging bilingual students and promote tasks that encourage and demonstrate high expectations for their performance.

Figure 4 PLP Emphasis on Culturally Responsive Teaching Item Frequencies



Note: *n*=3; Question stem asked, "In professional learning activities, either those you have planned or those you have enacted, to what extent does your PLP emphasize the importance of having teachers engage in each of the following?"

Items that all three PLP leaders reported a 1-*to a small extent* were those that encompassed teachers' use of social and political examples in class, designing lessons that represent different cultures, and ensuring that materials are free of biases and represent different cultures. This is contradictory to those items assessing students' perceptions of culturally responsive teaching in math class, which examined for aspects of making connections to social and political problems to the subject, and representation of students' backgrounds.

Chapter 7

DISCUSSION

With Bronfenbrenner's (1979; 1994; 2005) bio-ecological systems theory applied, the mathematics classroom serves as the microsystem where the proximal process of culturally responsive teaching happens, and the outcomes of this proximal process could influence the person (e.g., students' engagement) and their experiences in the mesosystem (e.g., interpersonal relationships in school, or integrated web of classroom microsystems). Moreover, the PLP leaders' initiatives make up the exosystem in this study, and this is evident given their level of emphasis and implementation of culturally responsive teaching resources. Findings showed that culturally responsive teaching did not predict engagement in math above and beyond grade level and instructional mode, but it was associated with higher ratings of interpersonal relationships at school without accounting for grade level or instructional mode. The PLP's implementation of culturally responsive teaching emerged as a set of strategies that focused on improving math outcomes for emerging bilingual students, and less on general strategies towards social and political discussions, assessing biases, and promoting representation. In their grant proposal, their goals highlighted a focus on improving students' engagement through providing tools to support emerging bilingual students.

For the macrosystem and chronosystem (i.e., time), the perspective of QuantCrit applies in interpreting disparate results as a product of systemic and institutional discrimination and oppression (e.g., Gillborn, 2018). Racial and socioeconomic inequities during the COVID-19 pandemic likely played a role in the extent to which students experienced culturally responsive teaching in the classroom, the quality of their interpersonal relationships at school, and their engagement. Students may not have had the resources or capacity to consistently attend class during the pandemic due to Internet inaccessibility, familial responsibilities, and coping with pandemic related deaths (de Figueiredo et al., 2021; Jones, 2021). Likewise, school building closures, and shifts from in-person to online modes of instruction probably affected the PLP's implementation of their goals related to facilitating teachers' use of culturally responsive teaching. While it is beyond the scope of this work, the PLP likely had to shift their proposed strategies. Their family engagement work may have been negatively affected, along with their plans for teacher training and professional development.

Bio-ecological systems and findings

Person and Process in the Microsystem

The first research question investigated the relationship between culturally responsive teaching in the microsystem of the math classroom and engagement. Regression results showed that culturally responsive teaching did not predict students' engagement in math. This finding is inconsistent with prior research (see Byrd, 2016; Hubert, 2014), which demonstrates that due to the process of culturally responsive teaching, students feel more interested and willing to complete tasks for math class.

Drawing on QuantCrit, the mechanisms by which this relationship occurs is potentially a product of person characteristics and proximal processes in the classroom microsystem, such as teachers' behaviors and expectations for students, and how students respond to their teachers' expectations and attitudes towards them (Thomas & Berry, 2019; Garcia & Chun, 2016). This study's measurement of culturally responsive teaching did not assess for students' perceived expectations and relationships with teachers, but this is a mechanism critical to students' engagement in math (Aronson & Laughter, 2016; Thomas & Berry, 2019). Students are more likely to be interested and invested in classes where they feel respected and cared for by their teachers (Garcia & Chun, 2016; Hubert, 2014; Sampson-Garrison Wade, 2011). Unfortunately, students who belong to communities that constantly challenge their oppression in the United States are likely to perceive that their teachers think poorly of them (Alliman-Brisset & Turner, 2010; Battey & Leyva, 2018; Ramlackhan & Wang, 2021; Young & Cunningham, 2021).

Although this study did not obtain respective demographic information for the students who took the survey, the sample came from a district and PLP serving predominately Latinx students. The focus of the PLP was also on emerging bilingual students. One study linking culturally responsive teaching to student academic outcomes with Latinx students, specifically of Mexican origin, revealed that culturally responsive teaching strategies that encompassed connecting lessons to real life situations and providing relevant examples and projects was associated with better academic self-efficacy (Garcia & Chun, 2016).

Importantly, the Latinx community is not a monolithic group; it is made of those from many ethnic groups, nations, and races. As such, teachers' use of culturally responsive teaching will vary based on students' cultural values and beliefs. For students who belong to Latinx groups, engagement probably emerges as a result of culturally responsive teaching strategies that are meaningful to them and their families; moreover, students of Latinx origins who are emerging bilinguals also benefit from strategies that draw on tangible cultural examples and their existing linguistic abilities (Yu et al., 2021).

The items that made up the culturally responsive teaching scale for this study touched on students' perceptions of their teachers' respect for their cultural background, discussing and doing projects around social or political issues, and using examples that are relevant to students' home lives and backgrounds. Assessment of the scale mean showed that students rated culturally responsive teaching in math class low. As mentioned prior, such low ratings likely resulted from challenges posed during the COVID-19 pandemic that hindered the goals that the PLP proposed for supporting teachers. In addition to that, another challenge to culturally responsive teaching was shifts in instructional mode, as over 70% of students in the sample reported receiving online or hybrid instruction.

For the sample of students that the PLP targeted for the overarching study, a longer set of items could have asked students the extent to which teachers connected lessons to specific familial values, traditions, and language, which in this case, could have better connected culturally responsive teaching to engagement. As with

Gutstein's (2016) study with Latinx and African American students where lessons connected family and home life to math using projects that encompassed communication with caregivers, students reported more interest and investment in the subject.

The regression also suggested that being a high school student (control dummy variable of grade level) negatively predicted engagement in math class. Research on the construct of engagement in high school populations demonstrate that along with teaching strategies that are relevant to the lives of students and animated with meaningful activities, academic rigor is one of the most important components to keep them engaged (Cooper, 2014). High schools with higher populations of students of color, emerging bilingual students, and students from communities of lower socioeconomic status have fewer opportunities for advanced math courses that are rigorous (Kolluri, 2018; Mosqueda et al., 2021). In 2020, a report by the *Education Trust* revealed that Black and Latinx students were unequally represented in advanced placement, or rigorous college preparatory coursework. Ultimately, this demonstrates that feeling challenged may lead to feeling capable and interested in math.

Interpersonal Relationships and the Mesosystem

The results of the regression examining the relationship between culturally responsive teaching in the math classroom and interpersonal relationships within the broader school environment, or mesosystem, was significant. Nevertheless, this association did not account for control variables of grade level or mode of instruction students experienced. First, the model that included these control variables was not significant. This nonsignificant finding could have been due to students in the sample reporting more online or hybrid instruction for changes in interpersonal relationships at school to occur. There might also be other factors that were not measured and accounted for in predicting interpersonal relationships at school.

The items for interpersonal relationships focused on students' experiences of being treated with respect by teachers, getting along with other students, and whether adults at school cared about them as a person. Culturally responsive teaching in the math class microsystem transferred into other classes and relationships within the school mesosystem, perhaps as a result of the sense of community and awareness that develops from this teaching strategy (Gay, 2018). A causal link cannot be determined in this case, but other studies have found linkages between culturally responsive teaching and improved peer interactions due to students developing more accepting attitudes towards each other (Byrd, 2016; Sampson & Garrison-Wade, 2011).

Additionally, what students gain from culturally responsive teaching travels outside of the microsystem into the mesosystem through what Renn and Arnold (2003) posed as congruence between "individual characteristics, microsystems, and mesosystems" (p. 278). Culturally responsive teaching in the microsystem involves conversations and activities around students' other microsystems to leverage their interests and experiences (Cantor et al., 2021; Gay, 2018). Connecting aspects of students' microsystems like home, classes, or areas where other activities and proximal processes occur reinforces peer collaboration and positive social outcomes (Byrd, 2016; Gutstein, 2016; Sampson & Garrison-Wade, 2011).

Despite the lack of survey specific demographic data in this study, culturally responsive teaching is essential for interpersonal relationships because it could dismantle ideologies that erase the schooling experiences of many students whose communities have been marginalized (Gregory et al., 2021). Students and teachers who become more aware of inequities and discrimination can transform school to be a place of belonging and inclusivity where diverse values and identities are validated as important sources of learning (Edwards & Edick, 2013). Racist and oppressive practices should be acknowledged by way of a culturally responsive education so that students can develop a positive sense of self and views about their peers.

The Exosystem

The exosystem is far removed from students, yet it contributes to their school microsystem and mesosystem. In the results for the third research question, the PLP's grant proposal and survey data stated that their work was geared towards improving math outcomes for emerging bilingual students. To do this, they centered family engagement, teacher professional learning, and curricula as areas to target in order to reach their goal for students. However, survey data showed little emphasis on culturally responsive teaching strategies for encouraging teachers to evaluate materials and lessons for cultural biases and incorporate cultural representation. The survey specifically showed aims for supporting emerging bilingual students. For example, they promoted modeling tasks for emerging bilingual students, and organizing tasks and activities that do not undermine their abilities.

The exosystem transforms students' learning experiences by advancing teachers' capacity to instruct and interact with them in ways that affirm their backgrounds and lived experiences (Song & Coppersmith's, 2020). The PLP's strategies and goals to foster teachers' culturally responsiveness with emerging bilingual students aligns with prior research (e.g., Villegas et al., 2018). It is advantageous for emerging bilingual students when teachers are supported in building better subject matter knowledge and relationships with their students (Villegas et al., 2018). Ultimately, the PLP proposed several resources to implement culturally responsive teaching in the school mesosystems (i.e., web of classrooms or school climate) and microsystems (i.e., immediate classroom), including building teacher peer collaboration and capacity via professional learning and training.

Perhaps another way to promote more cultural responsiveness from the exosystem to the microsystem was the family engagement component the PLP mentioned in their proposal. Promoting this component involves broadening students' mesosystems through facilitating communication between their school community, families, and educators. The school mesosystem of classrooms, or school climate, could collectively empower students when it welcomes and appeals to their families and communities. Including family in broader school activities and events pave way for teachers' ability to engage them in a classroom microsystem (Bonner & Adams, 2012; Bottoms et al., 2017). Indeed, for the population and grade level of students the PLP targets, familial communication regarding school differs for adolescents.

Specific to the general population in the PLP's district, schools' familial communication for Latinx students can benefit their academic trajectory, but there are barriers that stakeholders should note. One study evaluating Latinx adolescents and their families found that low socioeconomic status led to physical and emotional stressors, which affected the rate of familial involvement in school (Camacho-Thompson et al., 2016). This study did not assess for discrimination, yet families may also feel unwelcome at schools if they do not validate and respect their cultural values. Like many cultural groups, for Latinx communities, family plays a central role in their children's educational attainment (Carey, 2018; Carey, 2021; Pérez Huber et al., 2018). Understanding how to reach and appeal to families is important, and it is even more important to be mindful of how schools conduct outreach to families. Familial involvement for Black and Latinx communities may be most meaningful in the form of verbal communication about expectations, advice, and storytelling (Moodie & Ramos, 2014). Districts and initiatives working towards familial engagement should note and regard the cultural backgrounds of their students' families. In doing so, they can better prepare their schools and teachers in forming stronger mesosystems—those positive connections between students' home, neighborhood, and school lives.

The Macrosystem

Though not quantitatively measured in this study, the macrosystem is a major influence in how students experience culturally responsive teaching. Cultural values and beliefs in the United States about public school education are largely devoid of teaching about race and discrimination, though culturally responsive teaching is one way to acknowledge and tackle this. In schools, low cultural responsiveness can be a product of colorblind beliefs or race evasive ideology that ignores the existence of oppression (Annamma et al., 2017). Yet research that has investigated and reported racial, ethnic, gender, and ability disparities in education provides a concrete picture of how the education system was built to favor one group of students and marginalize the rest (Annamma et al., 2013).

Building on the fifth component of culturally responsive teaching as proposed by Gay (2018), teachers should be supported and prepared to critique and resist oppressive practices in order to fully embody a culturally responsive approach. Preparing teachers for culturally responsive teaching requires mindset shifts from beliefs that surface from the macrosystem. The macrosystem, as it pertains to traditional public-school education, is inundated with information that pits students against each other through promoting the notion that certain student demographics are lacking academically (Carey, 2014; Turner & Spain, 2020). Collecting data and disseminating findings about these disparities in teacher education and training can be harmful to teachers’ mindsets about student expectations, their behaviors towards students, and students' own self-concepts and peer interactions (Bertrand & Marsh, 2021; Johnson et al., 2019; Turner & Spain, 2020).

This correlational study showcased the prominence of culturally responsive teaching in a district that received funding to improve math outcomes for emerging bilingual students. It would be a disadvantage to students to not challenge oppressive beliefs about math education in the macrosystem, as students internalize these beliefs, and it negatively affects their academic and social wellbeing (e.g., Alliman-Brissett & Turner, 2010). Given the focus of the PLP in this study, emerging bilingual students have linguistic assets that teachers can highlight in the classroom. Math, for instance, is often noted as a universal language, and meaning making about math problems and solutions is not limited to English proficiency (Elfers & Stritikus, 2014). Reframing beliefs about teaching math is a necessity, along with building teachers' social and cultural awareness (Villegas et al., 2018).

Time

Considering the bio-ecological systems notion of time and culturally responsive teaching, the era in which this study took place was unique given that schools were not operating in a traditional, in-person manner. The culturally responsive teaching mesotime was often inconsistent, with students experiencing in-person learning then shifting to online learning at several points. These inconsistencies, especially during their developmental period of adolescence, were challenging for many students. During COVID-19 school shuttering, students across the United States may have witnessed death, intimate partner violence at home, hunger, and Internet inaccessibility (Wagner, 2020). These events played a role in their school attendance and experiences, especially for students from lower socioeconomic backgrounds and students who toil with institutional and systemic discrimination (Jones, 2021).

For adolescents, building and maintaining close social relationships plays a substantial role in their social and emotional health. Culturally responsive practices in their classroom microsystem and school climate mesosystem strengthen these social and emotional outcomes (Aronson & Laughter, 2016). With that in mind, COVID-19 school shutterings and shifts to non-traditional online instruction isolated students from social interactions, and thus tainted the opportunity for culturally responsiveness to bolster their mesosystems. Such isolation from relationships had imaginable detrimental consequences to many students' psychological wellbeing (de Figueiredo et al., 2021).

In sum, time plays a reasonable role in student outcomes and the interactions between their ecological systems. Culturally responsive teaching depends on time since implementation varies due to age, mode of instruction, and generation. Time is not an easily measured construct, but its inclusion in the assessment of culturally responsive teaching is informative.

Conclusion

As a final analysis, this study details how culturally responsive teaching functions from a bio-ecological standpoint. The sample in this study consisted of middle school and high school adolescents who are at an impressionable developmental stage that informs future academic aspirations (Oyserman et al., 2006; Smetana et al., 2006). The addition of culturally responsive teaching in bio-ecological systems presents a strong framework for examining the course of their academic outcomes.

Culturally responsive teaching is a proximal process that happens during students' microtime—the time in which they are receiving instruction in the math classroom. Students' interactions with each system are contingent on their own personal characteristics, and culturally responsive teaching weds their microsystems and strengthens mesosystems by appending culture, language, and home life into microtime math classroom instruction (Gay, 2018; Bronfrenbrenner & Morris, 2006; Renn, 2012). The outcome of engagement in math class simulates the bio-ecological components of the microsystem, mesosystem, exosystem, macrosystem, and time. Similarly, students' interpersonal relationships that exist in their schools' mesosystem, or web of classrooms, is a product of all of those bio-ecological components. Without including culturally responsive teaching into bio-ecological systems to understand outcomes like engagement and interpersonal relationships, there would not be a deeper analysis about the role that culture, time, personal characteristics, and social interactions play in students' academic lives.

Chapter 8

IMPLICATIONS

Implications for Future Research

Future quantitative studies that aim to advance work on culturally responsive teaching and bio-ecological outcomes should consider QuantCrit methodology, or critical perspectives that delve into complex systemic inequities and their effects on student outcomes. Historically, much of the traditional public school system in the United States and teacher preparation programs have privileged White, Western norms and values. Studies on this topic should acquire data about students' and teachers' unique characteristics, considering that race, gender, and so on affects the extent to which culturally responsive teaching occurs (Sleeter, 2008).

A finding for this study showed that the PLP emphasized culturally responsive teaching for emerging bilingual students, and these schools served mostly Latinx youth. Future studies that work with these populations of students need to speculate the influence of cultural values, beliefs, and norms that exist in Latinx communities. Most of all, studies with Latinx communities should aim to disaggregate racial and ethnic data to understand the cultural nuances that shape students' school experiences (see Pérez Huber et al., 2018).

In all, this study highlighted students' self-reported experiences with culturally responsive teaching. Student perspectives are important to evaluate the magnitude of culturally responsive teaching, and alongside this, future studies should also explore such teaching practices through observations (see Debnam et al., 2015). Given this study's analysis of students and PLP leaders, observational measures of culturally responsive teaching could best capture patterns in teachers' practices that respondents and survey items may not discern.

Implications for Practice

Implementing culturally responsive teaching entails communication between students' ecological systems. To clarify, stakeholders involved in transforming students' learning experiences in school can use the context component of bio-ecological systems theory to strategize where to best complement the magnitude of culturally responsive teaching. As an example, a student's exosystem reveals itself as a central component in prior literature on successful implementation of culturally responsive teaching (see Sleeter & Owuor, 2012).

The development and effectiveness of culturally responsive teaching is a product of numerous forces, including teachers' educational and training opportunities. Bottoms et al. (2017) studied how an experiential program for pre-service teachers strengthened their cultural responsiveness. The pre-service teachers who participated in this qualitative study attended a *Family and Science Nights* at a rural public school serving Latinx and Indigenous populations of elementary school students. They documented their reflections and observations about attending *Family and Science Nights*, which were events that students and their families participated in to engage in activities and projects about math and science. After ten weeks of participating in the event, the teachers felt more culturally competent about the students and families they worked with. They understood what assets families brought to their children’s academic skills and reflected on how they could leverage these assets in the classroom. This study supports the idea that programs or trainings that enhance teachers’ cultural knowledge about their students influence their confidence in implementing culturally responsive teaching (Brown et al., 2019; Cruz, 2020).

Similarly, Bottoms et al. (2017) study on pre-service teachers participating in *Family and Science Nights* is evidence that students’ mesosystem is another area where culturally responsive teaching can be bolstered. For example, the American Institutes for Research released a “Strategies for Equitable Family Engagement” resource guide that highlights ways to connect students’ home or community microsystems to school. Schools can strengthen microsystem connections in several ways, such as by providing language interpreters to facilitate communication between families and school staff, and partnering with community centers like libraries and organizations to support students’ learning outside of traditional school.

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Appendix

THE PROFESSIONAL LEARNING PARTNERSHIPS STUDY

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