PARENT PERCEPTION OF TEACHER QUALITY AND TEACHER CULTURAL SENSITIVITY AND RESPONSIVENESS AS MEDIATORS OF GROWTH IN MATHEMATICS UNDERSTANDING IN RACIALLY MINORITIZED AND NON-RACIALLY MINORITIZED HEAD START PRESCHOOLERS

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Abstract

The U.S. educational system fails to provide equitable educational experiences for racially minoritized students, also called racially minoritized learners (RMLs), who are from historically underrepresented racial and ethnic backgrounds, including African American/Black, Hispanic/Latinx, Asian American, Pacific Islander, and Indigenous backgrounds. Compared to their White peers, RMLs face sociocultural disparities as early as the preschool years that can lead to early gaps in learning opportunities and achievement in fundamental academic domains, such as mathematics, which are crucial for academic and career success. In early childhood education, parent perceptions of 1) Teacher Quality and 2) Teacher Cultural Sensitivity and Responsiveness (CSR) are positively related to the mathematics understanding of RMLs. Using a large-scale data set of diverse young learners, this study evaluated the effect of parents' perception of Head Start Teacher Quality and CSR in the early childhood Head Start centers on RMLs' growth in mathematics understanding over the course of one preschool year. Analyses were conducted using the base year data of the 2014-2017 Head Start Family and Child Experiences Survey (FACES), a nationally representative dataset of children enrolled in Head Start programs across the U.S. The goal of the current study was to evaluate whether or not RML status impacts mathematics understanding in Head Start preschoolers, and if so, to test whether Teacher Quality and Teacher Cultural Sensitivity Responsiveness mediate this relation. Children's RML status was related to their growth in mathematics understanding in Head Start Preschool. Contrary to hypotheses, Teacher Quality and Teacher CSR were not mediators of the relation between RML Status and growth in Mathematics Understanding. Thus, the current findings do not support the hypothesis that Teacher Quality and Teacher CSR influence RMLs Mathematics Understanding over the course of the preschool year. Investigations into the current

topic are timely and important as classrooms across the United States are growing to represent the cultural and linguistic diversity of the nation, but schools are failing to keep up with the changing needs of the evolving demographic of young students in the U.S.

Parent Perception of Teacher Quality and Teacher Cultural Sensitivity and Responsiveness as Mediators of Growth in Mathematics Understanding in Racially Minoritized and non-Racially Minoritized Head Start Preschoolers

People of color are projected to make up the majority of the U.S. population by 2043 (Ahmad & Hamm, 2013) and already make up the majority of U.S. preschoolers (U.S. Census, 2020). Likewise, diversity in early childhood classrooms is growing rapidly (Ponciano & Shabazian, 2012; Sanders at al., 2019). Between the Fall 2009 and Fall 2020, public school enrollment among White students decreased from 26.7 million to 22.6 million (National Center for Education Statistics, 2022). Troublingly, by 4th grade, scores on standardized tests of mathematics show evidence of unequal learning outcomes for racially minoritized learners (RMLs) relative to White students (NAEP, 2013). RMLs, also known as BIPOC (Black, Indigenous, and People of Color) individuals, are Black, Latinx, Asian, Pacific Islander, and Indigenous individuals who face educational challenges not faced by their White counterparts (Vakil & Ayers, 2019).

Evidence of this so-called "academic achievement gap" surfaces as early as 18 months of age on standardized tests of early cognition and continues to widen as children progress through early childhood (Loeb & Bassok, 2012). These early achievement gaps lead to later difficulties in academic success and educational attainment for students of color (Falkner, 2022; Gansen, 2019). The disparity (17%) in college degree attainment rates between Black and White students has remained the same for the past few decades, and the gap between Latinx and White students has increased from 18% to 25% in the same time (Cox, 2016; Kezar et al., 2021). By 2030, racially minoritized students are projected to make up over 57% of enrollment in K-12 public schools (U.S. Department of Education, n.d.), however, historically schools at all levels of the

U.S. system have consistently failed to produce equitable educational experiences for racially minoritized learners (Han, 2008; McGrady & Reynolds, 2013; Shonkoff et al., 2021).
One reason for this is that RMLs have been systemically underrepresented and underserved in many aspects of the educational system in the U.S.– from policy formation, funding allocation, opportunity accessibility, and services (Escayg, 2019; Hisle, 2022).

Variation Among Racially Minoritized Learners

Researchers often contribute to RMLs not being adequately represented in the literature (Milner, 2007). This gap in representation often takes place in classroom settings used for educational research studies, thus skewing the findings, and ultimately white-washing our understanding of early learning and development (Keiser et al., 2021; Milner, 2008). Henrich (2011) discusses that RMLs are often made invisible (e.g., ignored, unnoticed, stereotyped) in education because teachers can fail to meet their learning needs which contributes to feelings of isolation in the classroom. Although important, representing and categorizing RMLs is a complex decision. RMLs are often miscategorized in the wrong racial/ethnic group in general education which contributes to the lack of belonging they experience in addition to the existing academic achievement gap (Dhaliwal et al., 2020; US Department of Education, 2020). However, even when there is adequate representation of many racial/ethnic groups of interest, Asian American (AA) and Pacific Islanders (PI) are often lumped together despite this group's wide variability in maternal education, household income, and early home math experiences (Spikard, 2007). For example, AA students often score equally or higher on standardized mathematics tests than White students, while PI students often score among the lowest of all the ethnic categories measured by the U.S. government (NAEP, 2019; NAEP, 2020). In an attempt at inclusion, researchers can incidentally "erase" (fail to reveal) the unique struggles encountered

and contributions made by certain groups, particularly PI, South Asian, "West" Asian, and Middle Eastern groups. Conversely, the unique needs of East Asian students, who encounter many educational obstacles compared to their White counterparts (Yi et al., 2020), and unique educational obstacles compared to other groups of Racially Minoritized Learners (Yi, 2015), are often overlooked.

In this study, the final sample did not have enough participants who identified with Asian American, Pacific Islander, Multi-racial, Bi-racial, and Other Race categories to calculate accurate estimates for these groups. Additionally, Asian and Pacific Islanders were grouped together in the original dataset instead of coded as separate racial/ethnic groups. Therefore, the current study focused specifically on African American or Black, Hispanic or Latinx students as RMLs, and White students as non-RMLs. Ultimately, full representation of the world's populations is necessary for a complete understanding of development, and thus, should be upheld as a broad goal of the field of developmental science.

Head Start Teacher Quality

In early childhood education, Teacher Quality is informative of developmentally appropriate learning outcomes (i.e., social emotional learning, problem-solving skills, and meeting academic grade level standards) and positive classroom experiences of children (Hamre et al., 2013). Specifically, these positive experiences include practicing social emotional skills, developing a sense of belonging in the classroom community, and promoting curiosity towards education (Curenton et al., 2020). Teacher Quality can consist of the level of consideration Head Start Teachers exhibit toward children in their classroom. Head Start teachers are at the forefront of early child development as they provide the preliminary foundation for learning and exploration children experience in early childhood education (Burchinal et al., 2020). Positive

climates in classroom settings that are welcoming promote emotional and personal development as teachers express positive regard for children and children feel safe and feel loved (Sanders et al., 2019). Creating and sustaining a positive emotional climate in preschool classrooms supports the development of children's competency and social skills (Mendez et al., 2002). In light of the Sociocultural Theory, researchers highlight that having an advanced partner can improve students' learning outcomes (Gauvain, 2001; Vygotsky, 1978). A Head Start teacher, trained in developmentally-appropriate pedagogical techniques, can offer children tools that facilitate cognition. These tools are oriented around mathematical language, concepts, strategies, and procedures to create a generally positive early experience with math (Gauvain, 2001; Gauvain et al., 2011).

Indicators of Teacher Quality are always best measured by a neutral observer, but classroom experiences of children are relatively well understood and reported by parents. Parent's perception of their children's experience in early childhood education has been an informative indicator for researchers understanding the significance of Teacher Quality in early childhood education (Gunn et al., 2021). Researchers have found that if children are receiving quality educational experiences, engagement from their Head Start teachers, and a sense of belonging in the classroom, then they are more likely to perform better academically (Burchinal et al., 2021; Sanders et al., 2019).

Head Start Teachers' Cultural Sensitivity and Responsivity (CSR)

In early childhood classrooms, racially minoritized learners face many educational obstacles, including not adjusting to mainstream socialization, inadequate preparation, and disparities in disciplinary practices (Curenton et al., 2020; Hirschfield, 2008; Tenenbaum & Ruck, 2007). While such educational inequities are more apparent, others can be quite insidious

and difficult to measure. Unconscious bias training has become a popular target point to reduce teacher bias, but unless racism is addressed on a systemic level (Applebaum, 2019), teachers are likely to inadvertently perpetuate inequality in the interactions that occur with their students in elementary mathematics classrooms (Benitez, 2010; Kempf, 2020; Milner, 2008). One consequence of this is that implicit biases exhibited by teachers in the classroom can lead to perpetuation of inequality (Chin et al., 2020). RMLs may be receiving differential treatment in an early care setting yet this is not always explicitly observed by school staff due to the systemic issues existing in education that cannot be resolved by diversity, equity, and inclusion training and education alone.

Researchers posit that a major contributor of such disproportionate outcomes is the concept of teachers' lack of Cultural Sensitivity and Responsiveness (CSR), which is related to Teacher Quality, but still distinct. For example, RMLs are not provided the same opportunities as their non-RMLs peers due to differential treatment in instruction, assignment delivery, and evaluation by their instructors (McGrady & Reynolds, 2013; Tenenbaum & Ruck, 2007). RMLs are often disproportionately disciplined as their behaviors are more likely to be interpreted as "problem" behaviors (Gansen, 2021; Henry et al., 2021; Okonofua et al., 2016). Hirschfield (2008) further expands on "problem behaviors" by highlighting that prison inmate capacities across the United States are calculated from rates of early childhood deviancy. Specifically, BIPOC students experience disproportionate rates of early childhood expulsions, particularly boys, Black children, and Black boys. In fact, Black children are 3.6 times more likely to be suspended from preschool than are White preschoolers (Rock, 2017; U.S. Department of Education, 2016). This is particularly concerning as Black children make up only 19% of preschool enrollment, but comprise 47% of preschool suspensions (Gilliam et al., 2016). These

disproportionate suspensions of RMLs in preschool contribute to the existing academic achievement gap (Gregory et al., 2010). This disparity among RMLs in early childhood education has been linked to the "school to prison pipeline" ideology as it captures the educational practices and government policies that disproportionately place RMLs into the criminal justice system (Hirschfield, 2008). Therefore, Head Start Teacher's CSR in early education is critical as it may reduce the achievement gap experienced by RMLs.

Mathematics Understanding in RML and Non-RML Preschoolers

Given this evidence, disparities in parent perception of Teacher Quality and Teacher Cultural Sensitivity and Responsivity likely contribute to the measurable disparities in academic achievement that RMLs endure (Nasir & Hand, 2006). For example, compared to non-RMLs, RMLs, including Black, Latinx or Hispanic individuals, scored significantly lower on average, on the SAT, a standardized test designed to evaluate literacy, numeracy, analytical, writing, and problem-solving skills necessary for success in college. For the class of 2020, less than a quarter of Black students and less than a third of Latinx students met the college readiness math benchmark on the SAT (Smith & Reeves, 2020). Compared to White students' performance, RMLs scored an average of 20 points lower on 4th grade standardized mathematics assessments on the *Nation's Report Card*, which provides national results about public school students' academic performance pre-COVID (NAEP, 2019). The SARS-COV-2 pandemic, which began in late 2019, further exacerbated this disparity in academic achievement for racially minoritized learners, who scored 30 points lower compared to White students (NAEP, 2022). Mathematics in early childhood education is critical because it builds student's baseline skills and fosters critical thinking and logical reasoning (Marrero et al., 2014). The early introduction of mathematical concepts in education increases the preparedness and likelihood of successful employment as

children progress through grade school (Mcclure et al., 2017; Watts et al., 2014). It is crucial that we unify as a community of educators to work towards identifying ways in which we can equitably teach all learners.

Theoretical Background

Sociocultural Theory

The Sociocultural theory consists of three fundamental concepts: 1) social interaction has a significant role in student learning, 2) language is essential in student learning, and 3) learning takes place within the Zone of Proximal Development (Allman, 2018). For the purposes of this study, I focused on the first fundamental concept of the theory. Lev Vygotsky highlights in this theory that learning is mostly a social process in which learners develop by interacting with a more skilled partner (Vygotsky, 1978). An advanced partner, especially one trained in developmentally-appropriate pedagogical techniques, can offer children tools that facilitate cognition, around mathematical concepts, strategies, procedures, and a generally positive early experience with math (Gauvain, 2001; Gauvain et al., 2011).

This psychological theory is rooted in social interactions and culture within the learning environment, which emphasizes the significance of acknowledging the cultural and linguistic diversity of students in the classroom. Sociocultural theory focuses on the development learners make overtime in their respective environments. From a sociocultural perspective, mathematical instruction in the classroom provides an opportunity for children to engage in learning experiences with the guidance of a more experienced partner, often a teacher (Klibanoff et al., 2006; Vygotsky, 1978). Thus, this paper explores parent perceptions of Teacher Quality and Teacher CSR on the mathematical understanding at the end of the academic preschool year for RMLs and non-RMLs.

Teacher Cultural Sensitivity and Responsiveness is critical for early childhood education because it creates opportunities for RML and non-RMLs to engage with the classroom curriculum (Gunn et al., 2021). Lower levels of Teacher CSR are correlated with increased rates of disciplinary action for and differential treatment of RMLs in the preschool classroom (Gansen, 2021; Shonkoff et al., 2021). RMLs facing increased rates of disciplinary actions and differential treatment perform lower than their non-RML counterparts in the classroom (Debs & Brown, 2017; Park, 2011). Teacher CSR has been associated with preschoolers' math development, where higher levels of Teacher CSR are associated with gains in mathematics understanding for preschool children (Choi & Dobbs-Oates, 2013). The current study seeks to explore a) if RML status is correlated with growth in mathematics understanding over one preschool year, then b) do Teacher Quality and/or Teacher CSR mediate this relation between RML Status and growth in mathematics understanding over the course of one academic year?

Abolitionist Teaching

Cultural sensitivity is important in early childhood education because it creates a warm learning environment that is safe for all learners (Escayg, 2019; Peel & Peel, 1993). Students' learning is optimized in equitable learning situations (Breive, 2020; Jensen, 2014). This is likely due to several reasons. First, racially minoritized preschoolers have fewer mathematical opportunities compared to non-RMLs (Clements et al., 2021). Second, inclusive pedagogies, such as Abolitionist Teaching, foster greater interest in STEM fields among young children (Doucet & Adair, 2013; Kwong & Davis, 2015). Abolitionist Teaching is a new pedagogical approach aimed at reintroducing humanity in the classroom for learners of all backgrounds by ensuring equity and celebrating diversity (Kendi, 2019; Love, 2017; Love, 2021). The Abolitionist Teaching approach implements culturally and linguistically sustainable practices in

the classroom, including within lesson and/or curriculum plans, teacher-child classroom conversations, and also through fostering supportive teacher attitudes and equitable treatment of their students. There is progress taking place in the field of psychological and educational studies today as the scholarly community is heading towards placing more emphasis on researching equity and inclusion in real world settings (Escayg, 2019; Louis & King, 2022). To support this approach, the National Association for Education of Young Children (NAEYC) recently revised its standards on diversity to reflect the growing need to support BIPOC students (NAEYC, 2022), who face immense pressures, prejudice, and stigma in the classroom (Hirschfield, 2008; Hisle, 2022; Vakil & Ayers, 2019). The Abolitionist Teaching approach directly addresses these challenges by taking a holistic, child-centered approach to addressing current events through the lens of Critical Race Theory, lived experiences, and student belongingness in the learning process.

Additionally, inclusive pedagogical approaches create a learning environment in which students express feeling more physically, socially, and emotionally safe, which enables students to confidently progress in their STEM learning and pursue higher education (Kwong & Davis, 2015). Students who do not feel safe in their learning environments score lower on both reading and math standardized tests, leading to feelings of exclusion and hopelessness around learning and school (Vakil & Ayers, 2019). Thus, providing RMLs with equitable early mathematics instruction is crucial for preparing the next generation of STEM professionals (Mcclure et al., 2017; PCAST, 2012).

Sanders and colleagues (2019) highlight the implications of how Head Start preschool teachers' use of multicultural practices in the classroom includes embedding materials that are ethno-racially representative of the families attending the program. RML and non-RML children

may become more open toward racial and ethnic differences in society and appreciate cultural diversity when exposed to culturally diverse experiences and materials (D'Angelo & Dixey, 2001). Through teachers' utilization of culturally responsive pedagogical practices in early childhood education, children are more likely to succeed academically and build solid developmental foundations for learning (Gunn et al., 2021).

Racially Minoritized Learners Mathematics in Early Childhood Education

To my knowledge, no research has investigated the potentially mediating effect of parent perception of Teacher Quality and Teacher Cultural Sensitivity and Responsiveness on the Mathematics Development of racially minoritized learners in early childhood classrooms serving low-income communities. Understanding the effect of educational inequalities on preschoolers' mathematics performance is critical for achieving equity in early childhood mathematics classrooms. To this end, this study aims to answer the following research questions:

Research Question 1: Does RML status predict growth in mathematics understanding in Head Start preschoolers over the course of one year?

Research Question 2: If so, does parent perception of their child's Head Start Teacher Quality and Teacher Cultural Sensitivity and Responsivity mediate the relation between RML status and growth in mathematics understanding over the course of the year?

Method

Data Source

In order to address these questions, the Head Start Family and Child Experiences Survey (FACES) was utilized. FACES is a periodic series of longitudinal studies aiming at capturing the characteristics, experiences, and academic outcomes of nationally representative samples of the children, families, teachers, and classrooms that make up Head Start programs (Malone et al.,

2013). Currently, data for seven FACES cohorts have been published – FACES 1997, 2000, 2003, 2006, 2009, 2014, and 2019. The 2014 dataset was selected for its increased emphasis on the quality and characteristics of the classrooms, family engagement, programs, and staff over time. Although the 2019 dataset provides more recent data on the nature of preschool math learning in Head Start, the 2014 dataset was selected to avoid the confounding nature of the COVID-19 pandemic on the mathematics learning of racially minoritized learners. The FACES dataset is also unique in that it is nationally-representative of the children enrolled in Head Start programs in the United States. The sample consists of 180 Head Start programs, approximately 2 centers per program and 2 classrooms per center were selected for participation. 60 centers included child-level data collection in Fall 2014. In each classroom, approximately 12 children were selected to yield 10 participating children. After running the exclusion criteria (Table 1), the final sample consisted of 495 children.

Head Start

Head Start is an American federally funded preschool program aimed at supporting the growth and development of young children whose families are living at or below the U.S. federal poverty line. For enrollment in the 2014-2015 school year, the U.S. federal poverty guideline for a family of four was $23,850 annually. Head Start services support early learning, development, health, nutrition, and family well-being, and staff are trained on the significance of familial involvement throughout the program as a foundation for strong child outcomes. All programs provide center-based child development services, home based support, or family and child care related services. The mission of this program is for all families to receive high quality services in safe, healthy, and nurturing environments that prepare students for their later life (Tarullo et al., 2017; U.S. Department of Health & Human Services, 2022).

The FACES data series was selected for this study due to the great ethnic and racial diversity among their student body. In Head Start programs across the country, 42% of children are Hispanic/Latinx, 22% are African American, 28% are White, while the remaining 8% of children are of other races/ethnicities, including American Indian and Alaska Native, Asian, Pacific Islander, and multiracial and biracial designations.

Study Design

Using the 2014 FACES dataset, the start of the academic school year (Fall 2014) will be referred to as Time 1, and the end of the school year (Spring 2015) as Time 2. In doing so, I will be able to model the relation between children's RML status and their growth in Mathematics Understanding over the course of the preschool year.

Exclusion Criteria

For the purpose of this study, the final sample (n = 495) was selected from the data source using Child Age, Racial Minority Learner Status, Teacher Quality and Teacher Cultural Sensitivity and Responsiveness, and Math Understanding (Time 1 and Time 2) . See Table 1 for a summary of the exclusions made for missing values.

Table 1

Excluded Data Summary Table

Construct	**Variable(s)**	**Exclusion Criteria**	**Cases Meeting Exclusion Criteria in original dataset** (*n*)	**Cases Remaining in Sample after Criterion Applied** (*n*)
Child Age	P1RCAGE	value missing	357	2105

RML Status	CRACE	value missing	361	1909
Parent Report of Teacher Quality	P2W04_5A P2W04_5B P2W04_5C P2W04_5D P2W04_5E P2W04_5F	missing data on at least one of the variables contributing to the composite	1671	693
Parent Report of Teacher CSR (CSR)	P2W04_4B P2W04_4C P2W04_6A P2W04_6B P2W04_6C	missing data on at least one of the variables contributing to the composite	1677	685
Mathematics Understanding T1	A1WJAPW	value missing	414	570
Mathematics Understanding T2	A2WJAPW	value missing	508	546
RML Status	CRACE	value > 3 (race/ethnicity is not White, Black, Hispanic/Latinx)	143	495

Once this near-final sample (n = 546) was reached, the number of participants *not* belonging to the White, Black, and Latinx ethno-racial groups was calculated in order to assess whether there would be sufficient power to detect an effect (should it exist) for this already heterogeneous "Other Ethnicity" group. The majority of participants fell into racial categories: White (n = 154), Black (n = 181), and Latinx (n = 160), whereas only 51 participants met the criteria to be included in the "Other Ethnicity" group. These 51 students were American Indian or Alaska Native (n = 4), Asian or Pacific Islander (n = 3), Multi-Racial/Bi-Racial, Non-Hispanic (n = 40), and Multi-Racial/Bi-Racial, Hispanic (n = 4; Table 2).

Table 2

Descriptive Statistics for Excluded RMLs

Variable (n = 51)	RML Status *% (n)*
Child Ethnicity	
American Indian or Alaska Native	7.84% (4)
Asian American or Pacific Islander	5.88% (3)
Multi-racial / Bi-racial, non-Hispanic	78.43% (40)
Multi-racial / Bi-racial, Hispanic	7.84% (4)

Due to a lack of statistical power, these cases were excluded from the Main Analyses. Excluded cases were not mutually exclusive from one another, such that a child missing data on one key variable tended to be missing data on another. A formal analysis of the Asian American or Pacific Islander population who belong to the RML status category is beyond the scope of this paper, and these populations would be better served in an equitable and inclusive manner through focused investigations in the future. Future studies can be strengthened by including all races and ethnicities in the RML group.

Final Sample

The final sample included 495 preschoolers (M_{age} = 49.54 months, *SD* = 6.46; 51% girls). See Table 3 for Descriptive Statistics on Child Age, Child Gender, Maternal Education, Family Economic Risk Index, Dual Language Learner status, Child Immigration Status, CLASS, and Child Ethnicity.

Table 3

Descriptive Statistics for Demographic Variables

Variable (n = 495)	Full Sample M (SD)	RML status M (SD) n = 341	non-RML status M (SD) n = 154
Child Age (in months)	49.79 (6.46)	49.15 (6.97)	50.56 (6.75)
Child Gender (% female)	51%	52%	50%
Maternal Education			
Less than High School Diploma	21%	25%	11%
High school diploma or GED	30%	30%	30%
Voc/Tech-Assoc-Some College	30%	26%	38%
Bachelor's degree or higher	9%	9%	8%
missing (n = 50)			
Family Economic Risk Index max=3	1.4 (0.83)	1.54 (0.77)	1.01 (0.89)
missing (n = 50)			
Dual Language Learner Status			
% DLL	18%	25%	1%
Child Immigration Status			
% Yes	0.8%	0.9%	0.7%
CLASS	19.60 (2.77)	19.81 (2.51)	19.50 (2.88)
Child Ethnicity			
White	31%	–	100%
African American	32%	47%	–
Hispanic / Latinx	37%	53%	–

Statistical Power

Using G*Power Version 3.1.9.6 (Faul et al., 2009), a priori power analyses were conducted to determine the target sample size for a stepwise Linear Regression, setting the number of predictors to 10, an overestimate. In order to conduct the planned analyses with 95% power to detect an estimated medium effect size (f = .15), a sample of 172 children was needed.

The current sample (n = 495) easily exceeds this sample size estimate, indicating sufficient power.

Measures

As part of the Family and Child Experiences Study, parents and caregivers of participants completed the Parent Survey, which asked parents/guardians questions about family demographics, including age, gender, race, ethnicity, and their experiences with their Head Start program teacher and environment. The Parent Survey from the base year of FACES 2014 (Fall 2014 - Spring 2015) provided the variables that comprise the constructs Head Start Teacher Quality and Head Start Teacher CSR. Children's mathematical understanding measures came from direct assessments administered by experimenters.

Racial Minority Learner (RML) Status

Racial Minority Learner status was determined using the CRACE variable, which was created from seven different dichotomous race variables asking parents to state whether their child was: 1) White (Non-Hispanic), 2) African American (Non-Hispanic), 3) Hispanic/Latinx, 4) American Indian or Alaska Native, 5) Asian or Pacific Islander, 6) Multi-Racial/Bi-Racial (Non-Hispanic), and 7) Multi-Racial/Bi-Racial (Hispanic). The CRACE variable is based on Fall 2015 data. In the full dataset, some instances of CRACE were based on Spring 2016 data due to missing data or nonresponse in the Fall of 2015, however in the current sample (n = 495), 100% of responses on the CRACE variable were time invariant.

For the purposes of this study, students were considered RMLs if their parents identified them as Black or African American (Non-Hispanic), or Hispanic/Latinx, and students were considered non-RMLs if they identified as White (Non-Hispanic). As explained earlier, American Indian or Alaska Native, Asian or Pacific Islander, Multi-Racial/Bi-Racial (Non-

Hispanic), and other-identified participants were classified as RMLs, but excluded from analyses. In the final sample, there were 341 RMLs (69%) and 154 non-RMLs (31%).

Head Start Teacher Quality

The Family Provider/Head Start Teacher Perceptions section (P2W04_5) of the Parent Survey measured parents' perspectives on their child's Head Start teachers. Parents were instructed to "Please indicate how much the following words are like your Head Start Teacher." Parents rated teachers on the words a) "Understanding" (*P2W04_5A*), b) "Rude" (*P2W04_5B*), c) "Dependable" (*P2W04_5C*), d) "Impatient" (*P2W04_5D*), e) "Judgmental" (*P2W04_5E*), f) "Available" (*P2W04_5F*) on a 4-point scale (1 = *not at all like my teacher*; 4 = *exactly like my teacher*).

Composite. The (Parent Report of) Teacher Quality variable was constructed by summing the values for each Teacher Quality indicator to create a composite Teacher Quality score for each participant in the study (as rated by their parent/guardian). To ease the interpretation of correlations among the Teacher Quality items and to allow for the construction and analysis of a composite Teacher Quality variable, negatively scaled variables (P2W04_5B, P2W04_5D, and P2W04_5E) were reverse coded. Then, a simple sum was calculated using these three reverse coded variables and the three positively scaled items (P2W04_5A, P2W04_5C, P2W04_5F). All of the variables that make up this composite were part of the same scale, measured on a 4-point Likert scale. Correlations were calculated for each variable within this composite to check for reliability (Table 4). The internal consistency between the items when measuring the construct of interest are approximately within an acceptable range $\alpha = .700$ (Table 5).

Table 4

Correlations Among Teacher Quality Variables

Variable	Understanding (P2W04_5A)	Rude (5B)	Dependable (5C)	Impatient (5D)	Judgmental (5E)	Available (5F)
Understanding	–					
Rude	0.235***	–				
Dependable	0.612***	0.137**	–			
Impatient	0.180***	0.605***	0.099*	–		
Judgmental	0.199***	0.576***	0.113*	0.651***	–	
Available	0.660***	0.072	0.574***	0.045	0.064	–

Note. $^{\dagger}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. Variables Rude (P2W04_5B), Impatient (P2W04_5D), and Judgmental (P2W04_5E) were reversed coded prior to calculating correlations.

Table 5

Frequentist Individual Item Reliability Statistics

Item	If item dropped Cronbach's α
Understanding	0.656
Rude	0.705
Dependable	0.698
Impatient	0.713
Judgmental	0.708
Available	0.705

Note. Variables Rude (P2W04_5B), Impatient (P2W04_5D), and Judgmental (P2W04_5E) were reversed coded prior to calculating correlations.

Head Start Teacher Cultural Sensitivity and Responsiveness

The Family Provider/Head Start Teacher Perceptions section of the Parent Survey asked parents to rate their child's Head Start teacher on six indicators for Cultural Sensitivity and Responsiveness. These theoretically related indicators came from three different subscales (*Head Start Teacher Curiosity, Head Start Teacher Incorporates Culture, Head Start Teacher Judgment*) within the scale on Parent Perceptions of Teacher Quality on the Parent Survey. The specific indicators were selected and isolated from the other indicators on the scales, which either measured Teacher Quality (as seen above) or other constructs outside of the scope of the current study.

Head Start Teachers' Curiosity (P2W04_3B). Parents were asked to rate their child's Head Start teacher on how often teachers "ask about the cultural values and beliefs [parents] want the teacher to communicate to the child" on a scale of 1) strongly disagree, 2) disagree, 3) agree, or 4) strongly agree. This variable was dropped from the final composite due to the lack of internal consistency between the items when measuring the construct of interest, Teacher CSR (α = .656). Additionally, this variable was dropped from the overall composite because it was not feasible within the scope of this study for Head Start teachers to account for every family's individual cultural value and belief.

Head Start Teacher Incorporates Culture (P2W04_4). Parents were asked to rate their child's Head Start teacher on how often their child's Head Start teacher 1) "reflects the cultural diversity of students in activities (P2W04_4B) and 2) "communicates the cultural values and

beliefs I want my child to have" (P2W04_4C) on a scale of 1) strongly disagree, 2) disagree, 3) agree, or 4) strongly agree.

Head Start Teachers' Judgment (P2W04_6). This 3-question scale surveyed parents on their perspectives about the level of judgment received e by their Head Start teacher towards their child and family in the classroom. Parents were asked, "How strongly do you agree or disagree with the following statements? For each one, please tell me whether you 1) strongly disagree, 2) disagree, 3) agree, or 4) strongly agree. The options were as follows: My Head Start teacher judges my family because of our faith and religion (P2W04_6A), My Head Start teacher judges my family because of our culture and values (P2W04_6B), and My Head Start teacher judges my family because of our financial situation (P2W04_6C). It should be noted that the final indicator (P2W04_6C) of Teacher CSR relates to socioeconomic context, rather than culture, however, it was retained in this measure due to the increased intersectional nature of this specific question, given that the larger sample is all extremely low-income.

Composite. The (Parent Report of) Teacher Cultural Sensitivity and Responsiveness variable was constructed by summing the values of the standardized version of each of the Teacher CSR indicators to create a composite Teacher CSR score for each participant in the study ($\alpha = .715$). To ease interpretation of the correlations among the Teacher CSR items and to allow for the construction and analysis of a composite Teacher CSR variable, negatively scaled variables (P2W04_3B, P2W04_4B, and P2W04_4C) were reverse coded prior to the creation of the Teacher CSR composite. Correlations were calculated for each variable within the composite to check for reliability (Table 6). After dropping P2W04_3B, all variables within the composite indicated higher internal consistency ($\alpha = .715$; Table 7).

Table 6

Correlations Among Teacher CSR Variables

Variable r	Diversity (P2W04_4B)	Cultural Beliefs (P2W04_4C)	Caring (P2W04_6A)	Judges Culture (P2W04_6B)	Judges Finances (P2W04_6C)
Diversity	–				
Cultural Beliefs	0.734***	–			
Caring	-0.087	-0.085	–		
Judges Culture	-0.092	-0.058	.808***	–	
Judges Finances	-0.150***	-0.153***	.760***	0.819***	–

Note. $^{\dagger}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. Variables Judges Culture (P2W04_4B) and Judges Finances (P2W04_4C) were reversed coded prior to calculating correlations.

Table 7

Frequentist Individual Item Reliability Statistics

Item	If item dropped Cronbach's α
Teacher Curiosity	0.715
Diversity	0.607
Cultural Beliefs	0.603
Caring	0.659
Judges Culture	0.664
Judges Finances	0.646

Mathematics Understanding

The dependent variable, growth in mathematics understanding, was created using the Woodcock-Johnson-IV (WJ-IV) Applied Problems score at the start of the prekindergarten preschool year during October (A1WJAPW) and at the end of the same academic year during April (A2WJAPW). Mathematics is measured using the applied problems and calculation sub-tests. For the purpose of this study, we took students' math scores from the applied problems subtest of the WJ-IV. This subtest specifically measures mathematics achievement by asking students to analyze and solve practical problems. Some examples of questions students are presented in this section are, "How many circles are there?" and the subtest presents an arrangement of shapes for the student to discriminate among. Another example is basic calculations where students may be asked, "Mary went to sleep at 7 o'clock on Sunday night. She woke up at 6 o'clock on Monday morning. How many hours did she sleep?". The applied problems subtest therefore is a comprehensive overview of children's computational, rationale, and problem-solving skills (Woodcock et al., 2001). The Woodcock-Johnson-IV was given in English or Spanish depending on the child's preferred and/or most proficient language.

The test-retest reliability for the WJ-IV was in acceptable to excellent range of Cronbach's alpha (α = .83 - .95). The WJ-IV, indicating high content validity as well because the exam itself was designed to capture core curricular areas and achievement specified in federal legislation (Mather & McGrew, 2014). The construct validity for the WJ-IV ranged from moderate to strong in the math test loadings on the Cattell-Horn-Carroll Quantitative Knowledge domain which supplements the validity evidence.

Selection Bias and Potential Control Variables

Selection bias is an important consideration in the design of all research studies. In the current study, RMLs and non-RMLs will certainly vary on a number of factors in addition to their RML status, including but not limited to dual language learner status and immigration status. For this reason, a number of control variables discussed below were included in the model to limit possible alternative explanations due to selection bias.

Seven control variables that were considered for inclusion in the Main Analyses, including Child Age, Child Gender, Maternal Education, Family Economic Risk Index, Dual Language Learner Status, Immigration Status, and Classroom Quality (CLASS). Prior to conducting the Main Analyses, univariate ANOVAs (for continuous outcome variables) and Chi-square tests of independence (for categorical outcome variables) were conducted to test whether potential control variables differed across levels of the independent variable (i.e., non-RMLs who were White and RMLs who were African American/Black and Hispanic/Latinx). Variables were entered into the Main Analyses, but not necessarily the *final* mediation model, as control variables if they differed significantly between groups. More details on how the Control Variables were entered in the Main Analyses are provided in the Results section. See Table 3 for Descriptive Statistics on Child Age, Child Gender, Child Ethnicity, Family Economic Risk Index, Dual Language Learner status, and Maternal Education.

Child Age (in months; *P1RCAGE).* The mean age of all preschoolers was 49.53 (*SD* = 6.92; median = 51 months). In the current sample, 63.8% (*n* = 316) of Head Start children were 4-years-old and 36.2% (*n* = 179) were 3-years-old at the start of the program year.

To determine if there were pre-existing mean differences in age at Time 1 between RML and non-RML groups, an ANOVA conducted to test for differences in Child Age at Time 1 between groups showed that there were no differences, $F(2, 493) = 1.271$, $p = .26$. Because age

was not significantly different between groups, it was not included as a covariate in the Main Analyses predicting child Mathematical Growth.

Child Gender. Child gender was reported by parents on the Parent Survey. In the current sample, 51% of Head Start students were reported to be female (n = 254; male = 241). A chi-square test of independence revealed that there were no significant differences in the number of girls between groups, $\chi^2(2) = 0.315$, $p = .854$. Because gender was not significantly different between groups, it was not included as a covariate in the Main Analyses predicting child Mathematical Growth.

Maternal Education (*P1RMOMED*). Mothers were asked to indicate their highest level of education completed. Mothers had the options of selecting from the following responses: 1) Less than high school, 2) High school diploma or GED, 3) Vocational/technical/associate/some college degree, and 4) Bachelor degree or higher. A chi-square test of independence revealed that there were significant differences $\chi2(6) = 32.041$, $p < .0001$. Because Maternal Education was significantly different between groups, it was included as a covariate in the Main Analyses predicting child Mathematical Growth.

Family Economic Risk Index *(P1ECRISK).* Parents were asked about family risk characteristics, including maternal education (0 = *more than high school*; 1 = *less than high school*), poverty level (0 = *above poverty level*, 1 = *at or below poverty level*), and family structure (0 = *not a single-parent household*, 1 = *single-parent-household*), with higher scores indicating family economic risk. A chi-square test of independence revealed that there were significant differences, $\chi2(6) = 17.080$, $p < .0001$. Because family economic risk was significantly different between groups, it was included as a covariate in the Main Analyses predicting Mathematical Growth.

Dual Language Learner Status *(P1RHHLNG).* Preschoolers were classified as Dual Language Learners (DLLs) if their parents reported that the primary language spoken at home with the child (P1RHHLNG) is not English, and classified as non-Dual Language Learners (non-DLLs) as those whose parents primarily speak English with the child as non-DLLs. A chi-square test of independence revealed that there were significant differences in the number DLLs between RML groups, $\chi 2(2) = 142.20$, $p < .0001$. Because DLL Status was significantly different between groups, it was included as a covariate in the Main Analyses predicting Mathematical Growth.

Child's Immigration Status (*P1CBRNUS*). Parents were asked to report their child's country of birth by responding to the following question, "Please tell me what country your child was born in." Parents selected their country from a drop-down list, which included options for "USA", Mexico, Guatemala, Cuba, Dominican Republic, India, China, Philippines, Japan, Korea, Vietnam, Guam, Samoa, another country (specify), Don't know, and refused. An analysis to test for differences in immigration status was not conducted because only four ($n = 4$) children were identified by their parents as immigrants. Because there are too few children in the "Immigrant" category, Immigration Status was not included as a covariate in the Main Analyses predicting Mathematical Growth.

Classroom Assessment Scoring System *(CLASS).* The CLASS measures classroom quality in center-based preschool classrooms, such as Head Start. The CLASS measures five domains, CLASS Positive Climate Score (O2CLSSPC), CLASS Negative Climate Score (O2CLSSNC), CLASS Emotional Support Score (O2CLSSES), CLASS Quality of Feedback Score (O2CLSSQF), CLASS Instructional Support Score (O2CLSSIS), and CLASS Regard of Student Perspectives Score (O2CLSSSP), which are strongly associated with student

achievement and development. Each Head Start teacher in the study was rated by trained FACES observers on the CLASS, and thus, each teacher has a score on this variable (not each child; aka Level 2 variable).

An ANOVA conducted to test for differences in classroom quality as measured by the CLASS between groups showed that there were significant differences, $F(2, 464) = 29.86$, $p = .048$. Because CLASS was significantly different between groups, it was included as a covariate in the Main Analyses predicting Mathematical Growth. Including this control variable for classroom quality will change the interpretation of the results, such that it allows me to evaluate the effect of Teacher Quality and Teacher CSR for each individual student on preschoolers' mathematical growth over one year above and beyond the effect of classroom quality for all students. CLASS provides a baseline for how HS teachers interact with children and delivers a curriculum which provides more insight to further explore Teacher Quality and CSR. In this way, the Main Analyses are rather conservative.

Composite. The CLASS variable was constructed by summing the values of the standardized version of each of the Teacher CSR indicators to create a composite Classroom Quality score for each participant in the study. The variable Negative Classroom Climate (O2CLSSNC) was reversed coded prior to calculating correlations. Correlations were calculated for each variable within the composite to check for reliability (Table 8). The internal consistencies among the items within the Classroom Quality composite are all above $\alpha > .700$, indicating a reliable measure (Table 9). The reliability of Classroom Quality was within an acceptance to the excellent range of Cronbach's alpha ($\alpha = .817$).

Table 8

Correlations Among Classroom Quality Variables

Variable r	Positive Climate (O2CLSSPC)	Negative Climate (O2CLSSNC)	Emotional Support (O2CLSSES)	Quality Feedback (O2CLSSQF)	Instructional Support (O2CLSSIS)	Student Perspective (O2CLSSSP)
Positive Climate	–					
Negative Climate	0.337***	–				
Emotional Support	0.896***	0.473***	–			
Quality Feedback	0.337***	-0.020	0.375***	–		
Instructional Support	0.374***	-0.026	0.395***	0.956***	–	
Student Perspectives	0.700***	0.228***	0.881***	0.396***	0.406***	–

Note. †$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$. Variable Negative Climate (O2CLSSNC) was reverse coded prior to calculating correlations.

Table 9

Frequentist Individual Item Reliability Statistics

Item	If item dropped Cronbach's α
Negative Climate	0.847
Positive Climate	0.774
Emotional Support	0.764

Instructional Support	0.767
Student Perspective	0.770
Quality Feedback	0.788

Note. Variable Negative Climate (O2CLSSNC) was reverse coded prior to calculating correlations.

Original and Derived Variables

An index of original and derived variables is presented in Tables 10 and 11.

Table 10

Original Variables

Variable Name	Names of Variable(s) from the FACES Dataset Name
Child Age	P1RCAGE
Child's Gender	CHGENDER
Maternal Education	P1RMOMED
Family Economic Risk Index	P1ECRISK
Dual Language Learner Status	P1RHHLNG
Child's Immigration Status	P1CBRNUS
Child's Race/Ethnicity	CRACE
Mathematics Understanding at the beginning of the preschool year (Time 1)	A1WJAPW
Mathematics Understanding at the end of the preschool year at (Time 2)	A2WJAPW

Table 11

Derived Variables

Variable	FACES Dataset Names of Variable(s) Involved		How Variable was Constructed
Classroom Quality	O2CLSSSP O2CLSSPC O2CLSSNC	O2CLSSQF O2CLSSIS O2CLSSES	sum (variables all on the same scale)
Teacher Quality	P2W04_5A P2W04_5B P2W04_5C	P2W04_5D P2W04_5E P2W04_5F	sum (variables all on the same scale)
Teacher CSR	P2W04_4B P2W04_4C	P2W04_6A P2W04_6B P2W04_6C	sum of standardized variables (variables from the same scale, but different subscales)
Growth in Mathematics Understanding over the preschool year (Time 2 - Time 1)	A1WJAPW A2WJAPW		A1WJAPW - A1WJAPW

Hypotheses

Research Question 1

The first research question asks if RML status predicts Head Start preschoolers' growth in mathematics understanding over the course of one year. I hypothesize that, controlling for Maternal Education, Family Economic Risk Index, Dual Language Learner Status, and Classroom Quality, RML status will predict mathematics growth over the course of the year. I expect racially minoritized learners will score lower on a standardized test of mathematics compared to non-racially minoritized learners at the end of the year (Clements et al., 2021).

Research Question 2

The second research question asks (retaining any significant control variables from the previous analysis) if Teacher Quality and/or Teacher Cultural Sensitivity and Responsiveness mediate the relation between RMLs and Head Start preschoolers' growth in mathematics understanding over the course of one year. Based on previous literature (Curenton et al., 2020; Escayg, 2019; Han, 2008), I hypothesize that Teacher Quality and Teacher Cultural Sensitivity and Responsiveness will mediate the relation between RML status and mathematics understanding, such that higher Teacher Quality and higher Teacher CSR will theoretically lead to more equitable gains (i.e., greater gains for RMLs) in mathematics understanding for RMLs. If a significant partial (or full) mediation is found for Teacher Quality, it will mean that the existing differences in mathematics learning for RMLs and non-RMLs are due in part (or full) to variation in Teacher Quality between individual students (RMLs vs. non-RMLs). If a significant partial (or full) mediation is found for Teacher CSR, it will mean that the existing differences in mathematics learning for RMLs and non-RMLs are due in part (or full) to variation in Teacher CSR between individual students (RMLs vs. non-RMLs).

Results

Descriptive Statistics

Prior to addressing main study aims with the Main Analyses, Descriptive Statistics for constructs of interest, Teacher Quality and Head Start Teacher Cultural Sensitivity and Responsiveness, and control variables, Child Age, Child Gender, Maternal Education, Family Economic Risk Index, Dual Language Learner Status, Immigration Status, and CLASS, were calculated. Means and standard deviations for the full sample as well as for RMLs and non-RMLs are shown in Table 12 and 13. Table 12 shows the descriptive statistics for the following

mediators: Parent Report of Teacher Quality, Parent Report of Teacher CSR, and RML status. Table 13 shows the descriptive statistics specifically pertaining to mathematics understanding.

Table 12

Descriptive Statistics for Mediators: Parent Report of Teacher Quality, Parent Report of Teacher CSR in the Full Sample and by Ethnicity

Variable	Full Sample *M* (*SD*)	White *M* (*SD*)	Black *M* (*SD*)	Latinx *M* (*SD*)
Teacher Quality	21.60 (2.68)	21.95 (2.82)	21.12 (2.81)	21.72 (2.36)
Teacher Cultural Sensitivity Responsivity	16.62 (2.71)[a]	17.21 (2.33)	16.35 (2.69)	16.37 (2.94)

Note. Mean and Standard deviation reflect the unstandardized variable values (with a summed composite).

Table 13

Descriptive Statistics Mathematics Understanding

Variable	Time 1 *M* (*SD*)	Time 2 *M* (*SD*)	Growth *M* (*SD*)
Child Ethnicity			
White	389.38 (29.69)	401.81 (25.60)	12.42 (20.44)
African American/Black	370.06 (32.30)	387.68 (27.54)	17.61 (25.26)
Hispanic/Latinx	375.52 (32.73)	392.92 (27.00)	17.40 (21.65)

Correlations

Associations Among Control Variables

First, correlations between control variables were calculated (Table 14).

Table 14

Correlations between All Main Variables

	1 r	2	3	4	5	6	7	8	9	10	11
1. Child Age	1										
2. Mat Ed [a]	-.13**	1									
3. Econ Risk[a]	.04	-.48***	1								
4. DLL Status[b]	.06	-.28***	.09*	1							
5. CLASS	-.003	-.11*	.05	.14**	1						
6. RML Status	-.09	-.13**	.26***	.29***	-.05	1					
7. Teach Qual	-.01	.06	-.09†	-.003	-.008	-.09*	1				
8. Teach CSR	-.004	.21***	-.17***	.18***	-.08	-.16***	.53****	1			
9. Math T1	.51***	.02	-.11*	-.08†	.03	-.23***	.08†	.02	1		
10. Math T2	.48***	.00	-.09†	-.04	.07	-.19***	.09†	.12*	.73***	1	
11. Math Growth	-.15***	-.03	.05	.05	.04	.10*	.08†	.00	-.56***	.16***	1

Note: †$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$. Variable abbreviations: Mat Ed = Maternal Education, Econ Risk = Family Economic Risk Index, DLL Status= Dual Language Learner Status, Teach Qual = Teacher Quality, and Teach CSR = Teacher Cultural Sensitivity and Responsiveness.

[a]Spearman's correlation coefficient calculated for the relations between specified variables to account for the ordinal measurement level of the Maternal Education and Family Economic Risk variables.

[b]Point-biserial correlation coefficient calculated for the specified relations to account for the nominal measurement level of the DLL Status variable.

Child Age and Maternal Education. There was a significant correlation between Child Age and Maternal Education, $r = -.13$, $p = .006$, indicating that more educated mothers tended to have younger children. This correlation is somewhat surprising; however, it appears to be a trend in the current sample that the older a preschooler is at Time 1, their mother was likely to have obtained lower levels of education compared to mothers of younger children. Spearman's correlation coefficient was calculated to account for the ordinal measurement level of the Maternal Education variable.

Child Age and Family Economic Risk Index. There was not a significant correlation between Child Age and Family Economic Risk Index, $r = .04$, $p = .379$, indicating that Child Age is not significantly linked to Family Economic Risk. Spearman's correlation coefficient was calculated to account for the ordinal measurement level of the Family Economic Risk variable.

Child Age and Dual Language Learner Status. There was not a significant correlation between Child Age and Dual Language Learner Status, $r = .06$, $p = .204$, indicating that Child Age is not related to whether a child is a dual language learner or not. A point-biserial correlation coefficient was calculated to account for the nominal measurement level of the DLL Status variable.

Child Age and Classroom Quality. There was not a significant correlation between Child Age and the Classroom Quality using the CLASS measure $r = -.003$, $p = .944$, indicating that Child Age is not associated with Classroom Quality.

Maternal Education and Family Economic Risk Index. There was a significant correlation between Maternal Education and Family Economic Risk Index $r = -0.48$, $p < .0001$. This indicates that children of mothers with lower levels of education belonged to families with greater economic risk.

Maternal Education and Dual Language Learner Status. There was a significant correlation between Maternal Education and Dual Language Learner Status $r = -.28$, $p < .001$. This correlation highlights how mothers with lower levels of education tended to have children who were Dual Language Learners compared to mothers with higher levels of education.

Maternal Education and Classroom Quality. There was a significant correlation between Maternal Education and Classroom Quality $r = -.11$, $p = .03$, indicating that mothers with lower levels of education reported their children experiencing higher Classroom Quality.

Family Economic Risk and Dual Language Learner Status. There was a significant correlation between Family Economic Risk and Dual Language Learner Status $r = .09$, $p = .047$, indicating that the greater economic risk experienced by families, the more likely they were to have a child who was a Dual Language Learner.

Family Economic Risk and Classroom Quality. There was no correlation between Family Economic Risk and Classroom Quality, $r = .05$, $p = .353$. This indicates that family economic risk and classroom quality were unassociated, such that preschoolers from the full range of family economic risk backgrounds (from great risk to lowest risk) were present in classrooms of all qualities (from lowest quality to highest quality), in general.

Dual Language Learner Status and Classroom Quality. There was a significant positive correlation between Dual Language Learner Status and Classroom Quality, $r = .14$, $p = .003$. This indicates that parents of Dual Language Learners tended to rate their children's classrooms as higher quality on average compared to parents of English-only language learners.

Associations between Control Variables and Constructs of Interest

Next, the associations between control variables and constructs of interest were calculated (Table 14).

Child Age. Child's Age was unrelated to Teacher Quality, $r = -.01$, $p = .780$, and unrelated to Teacher CSR, $r = -.004$, $p = .923$, indicating that Child Age was not associated with either Teacher Quality or Teacher CSR. However, unsurprisingly, Child Age was correlated with Mathematics Understanding at Time 1, $r = .51$, $p < .0001$ and at Time 2, $r = .48$, $p < .0001$ with older children scoring better than younger children at both timepoints. Additionally, Child Age and Mathematics Understanding Growth was correlated, $r = -.15$, $p = .0005$, such that Mathematics Understanding over the course of the preschool year increased more in younger students than older students.

Maternal Education. There was no correlation between Maternal Education and Teacher Quality $r = .06$, $p = .246$. This indicates that Mothers' level of education was not related to parents' ratings of Teacher Quality. However, Maternal Education was significantly correlated with Teacher CSR $r = .21$, $p < .001$, such that more educated parents tended to rate their children's teachers higher on Teacher CSR. There was no correlation between Maternal Education and Mathematics Understanding at Time 1, $r = .02$, $p = .693$ or Time 2, $r = .00$, $p = .999$. Lastly, there was no correlation between Maternal Education and Mathematics Understanding Growth, $r = -.03$, $p = .571$.

Family Economic Risk Index. The relation between Family Economic Risk and Teacher Quality was negative and marginally significant, $r = -.09$, $p = .07$, indicating that families at greater economic risk compared to those families with greater economic resources (within the low-income Head Start population) may tend to rate their children's teachers lower on Teacher Quality. There was also a negative correlation between Family Economic Risk Index and Teacher CSR, $r = -.17$, $p < .001$, meaning that families at greater economic risk are reporting lower levels of Teacher CSR on average. There was a significant correlation between Family Economic Risk and Mathematics Understanding at Time 1, $r = -.11$, $p = .02$, and a marginal relation at Time 2, $r = -.09$ and $p = .06$, however, there was no significant relation between Family Economic Risk and preschoolers' growth in Mathematical Understanding, $r = .05$, $p = .294$, over the course of the preschool year.

DLL Status. There was no association between Dual Language Learner Status and Teacher Quality, $r = -.003$, $p = .942$. However, there was a significant relation between DLL Status and Teacher CSR, $r = .18$, $p < .001$, indicating that Teachers of DLLs tended to be rated higher by parents on Teacher CSR. Further, there was a marginal correlation between DLL Status and Mathematics Understanding at Time 1, $r = -.08$, $p = .087$, indicating that DLLs tended to score lower on mathematics at the start of the year compared to their monolingual peers. However, there was no relation between DLL Status and Mathematics Understanding at Time 2, $r = -.04$, $p = .299$, or Mathematical Understanding Growth, $r = .05$, $p = .236$.

Classroom Quality. Classroom Quality was not related to Teacher Quality, $r = -.008$, $p = .861$, Teacher CSR, $r = -.08$, $p = .106$, Mathematics Understanding at Time 1, $r = .03$, $p = .523$, Mathematics at Time 2, $r = .07$, $p = .153$, or Mathematical Understanding Growth $r = .04$, $p =$

.424. These correlations highlight that Classroom Quality was not significantly associated with any main constructs of interest.

Associations Among Constructs of Interest

Last, the associations among the constructs of interest were calculated (Table 14).

RML Status. There was a significant relationship between RML status and Teacher Quality, $r = -.09$, $p = .047$, such that parents of RMLs reported lower levels of Teacher Quality compared to parents of non-RMLs. There was also a correlation between RML status and Teacher CSR, $r = -.16$, $p < .001$, suggesting that the RML status and Teacher CSR are related in the sample, such that parents of RMLs are likely to rate their children's teachers lower on Teacher CSR than parents of non-RMLs. Children's' RML status was significantly correlated with Mathematics Understanding at Time 1, $r = -.23$, $p < .001$, Mathematics Understanding at Time 2, $r = -.19$, $p < .001$, and Mathematics Understanding Growth, $r = .10$, $p = .021$. Taken together, these correlations indicate that RMLs demonstrated poorer mathematical performance than their non-RML peers at T1 and T2. However, there was a positive correlation among RMLs and Math Understanding, indicating that RMLs were showing greater growth in Mathematics Understanding compared to non-RMLs.

Teacher Quality. There was a significant moderate correlation between Teacher Quality and Teacher CSR $r = .53$, $p < .001$, indicating teachers rated higher on Quality tended to also be rated higher on CSR. The relations between Teacher Quality Mathematics Understanding at Time 1, $r = .08$, $p = .072$, at Time 2, $r = .09$, $p = .055$, and growth in Mathematics Understanding, $r = .08$, $p = .079$ were all marginally significant. This indicates that Head Start Teacher is related to preschoolers' Mathematics Understanding at the start of the year, at the end school year, and to their growth in mathematics understanding throughout the year.

Teacher CSR. There was no correlation between Teacher CSR with Math T1, $r = .02$, $p = .663$. It follows that Teacher CSR is not correlated with the Mathematical Understanding, $r = .00$, $p = .998$, as had not yet started the school year. Teacher CSR was significantly correlated with Math T2, $r = .12$, $p = .010$, indicating that Teacher CSR is associated with preschoolers' Math Understanding at T2. Following this, Teacher CSR was surprisingly not correlated with growth in Mathematics Understanding, $r = 0$, $p = .998$. This indicates that CSR did not bolster children's Mathematics Understanding throughout the preschool year.

Mathematics Understanding (Time 1, Time 2, and Growth). Mathematical understanding at Time 1 was strongly correlated with Mathematical Understanding at the end of the preschool year, $r = .73$, $p < .001$. Additionally, Mathematical growth was moderately correlated with mathematical understanding at the beginning of the school year (T1), $r = -.56$, $p < .001$.

Main Analyses

Using *R* Version 4.2.2, a mediation was conducted using a series of stepwise hierarchical linear regressions to test the influence of Teacher Quality and Cultural Sensitivity Responsivity on the relation between Racial Minority Learner (RML) Status and growth in preschool math understanding over the course of one year in Head Start. Missing data was handled using full information maximum likelihood estimation (FIML; Enders, 2008).

Weights and Standard Errors

The Main Analysis allows for the comparison of growth in Mathematics Understanding across the preschool year. Throughout the analyses, a sampling weight (P21RA2WT) was used to adjust for potential selection biases resulting from the unequal selection of the sample. Further, the nesting issue of children being nested in Primary Sampling unit (PSU) and sharing

the same geographic region was accounted for statistically, so that standard errors and a chi-square test of model fit will be computed by taking into account non-independence of observations in Family and Child Experiences Study due to cluster sampling (Muthén & Muthén, 2017).

Assessing the Control Variables

Stepwise hierarchical linear regressions were conducted to examine whether RML status predicted growth in Mathematics Understanding. First, Maternal Education, Family Economic Risk, Dual Language Learner Status, and Classroom Quality were entered simultaneously as control variables into the first step of Model 1 shown in Table 15. Overall, Model 1 was not statistically significant, $F(4, 490) = 0.41$, $p = .80$, $R^2 = .023$. No predictors were significant predictors of growth in Mathematics Understanding, so no Control Variables were retained in subsequent Models. For all regressions, the adjusted R^2 statistic is used to adjust for bias in the unadjusted estimates.

Table 15

Main Analysis: Multiple Regression Models Predicting Growth in Mathematics Understanding

	Growth in Mathematics Understanding Unstandardized *B*(*SE*) Estimates		
Predictors:	Model 1 *Control Variables*	Model 2 *RML Status*	Model 3: *RML Status, Teacher Quality, Teacher CSR*
Intercept	8.02 (9.71)	10.95*** (2.73)	16.63 (9.96)
Mat Ed	0.87 (1.45)		

DLL Status Yes (1)	1.09 (3.08)		
Econ Risk	1.80 (3.08)		
CLASS	0.17 (0.41)		
RML Status African-American Hispanic/Latinx		5.19* (2.54) 4.98* (2.47)	5.12* (2.59) 4.68† (2.53)
Teacher Quality			-0.19 (0.45)
Teacher CSR			0.19 (0.35)
F-statistic	0.41	3.84*	1.26
Adjusted *R*-Squared	0.023	0.07	0.020

Note: †$p < .10$, *$p < .05$, **$p < .01$, *$p < .001$. Variable abbreviations: Mat Ed = Maternal Education, Econ Risk = Family Economic Risk Index, DLL Status= Dual Language Learner Status, Teach Qual = Teacher Quality, and Teach CSR = Teacher Cultural Sensitivity and Responsiveness.

Predicting Mathematics Growth from RML Status

RML Status was entered into Step 2 of Model 2 (Table 15) to examine whether RML Status predicted performance on preschoolers' growth in Mathematics Understanding over the course of one year in Head Start. RML Status was a significant predictor (B_{Black} = 5.19, p = .04; B_{Latinx} = 4.98, p = .04) on Mathematics Growth in Model 2, $F(2, 492) = 5.52$, p = .0009, R^2 = .07.

Predicting Mathematics Growth from RML status and Teacher Quality and Teacher CSR

Regression analyses were conducted to examine whether RML Status, Teacher Quality, and Teacher CSR predicted performance on preschoolers' growth in Mathematics Understanding over the course of one year in Head Start. Next, Teacher Quality and Teacher CSR were then entered into the third step of Model 3 (Table 15). Model 3 was not significant overall, $F(4, 490) = 1.26$, $p = .29$, $R^2 = .020$. RML Status was a significant predictor of growth in Mathematics Understanding for African American/Black students ($B_{Black} = 5.12$, $p = .04$), and a marginally significant predictor for Hispanic/Latinx learners ($B_{Latinx} = 4.68$, $p = .06$) in Model 3. Teacher Quality ($B = -0.19$, $p = .67$) and Teacher CSR ($B = .19$, $p = .58$) were not significant predictors of growth in Mathematics Understanding.

Summary of Main Analyses

In Model 1, Control Variables, Maternal Education, Dual Language Learner Status, Family Economic Risk, and CLASS were not significant predictors of Mathematics Growth. Because there were no significant control variables predicting Mathematics Growth in Model 1, none were retained in subsequent Models.

In Model 2, RML status (split into African American or Black and Hispanic/Latinx) was entered into the Model, showing that the Mathematics Understanding of African American/Black students grew significantly more than White students and the Mathematics Understanding of Hispanic/Latinx students RMLs grew significantly more than their White peers over the same time.

In Model 3, the final Model was conducted by retaining RML Status as predictors and adding Teacher Quality and Teacher CSR to the model to test whether these variables would mediate the significant relations between RML Status and Mathematics Growth, for African American/Black and for Hispanic/Latinx students (shown in Model 2). Contrary to my

hypothesis, Teacher Quality and Teacher CSR did not mediate the relationship between RML Status and Mathematics Understanding over the course of the preschool year. After including Teacher Quality and Teacher CSR in Model 3, neither were significant predictors of growth in Mathematics Understanding, but RML Status for African American/Black students remained a significant predictor. However, for Hispanic and Latinx students, Mathematics Understanding over the course of the year became marginally significant. This indicates that in the current sample, Teacher Quality and Teacher CSR did not explain the relation between belonging to a racially minoritized group and students' growth in Mathematics over the course of the preschool year, contrary to my predictions.

Exploratory Analyses

Analysis 1: Examining Predictors of Mathematics at Time 2. Because the Main Analyses must be interpreted in terms of Mathematics Growth as the outcome variable, I also conducted supplementary regression analyses swapping the dependent variable from Mathematics Growth to Mathematics at Time 2 (Table 16). In the previous analysis, it may appear as if RMLs exceed at Mathematics relative to their White peers by Time 2. In fact, although RMLs start the school year with significantly lower Mathematics scores than non-RMLs, and RMLs grow their Mathematics Understanding at a more rapid rate than their White counterparts, Exploratory Analysis 1 shows that RMLs are still not catching up to non-RMLs in terms of Mathematics Understanding by Time 2 (Table 16), $F(5, 489) = 111.00$, $p < .001$. African American/Black students are not catching up by T2 in terms of raw averages (M = 387.68; Table 13), however they are showing growth in their Mathematics Understanding from T1 to T2 by this point. Similarly, Hispanic/Latinx students are not catching up in their

Mathematics Understanding by T2 in terms of raw averages (*M* = 392.92), however they are also showing growth from T1 to T2 by this point.

Table 16

Exploratory Analysis 1: Examining Predictors of Mathematics at Time 2

	Model 4 Mathematics Understanding at Time 2 Unstandardized *B*(*SE*) Estimates
Intercept	167.74** (13.16)
Math T1	0.57*** (0.03)
RML Status	
African-American	-2.19 (2.21)
Hispanic/Latinx	-0.33 (2.13)
Teacher Quality	-0.03 (0.38)
Teacher CSR	0.36 (0.29)
F-statistic	111.00***
Adjusted *R*-Squared	0.53

Note: $^{\dagger}p < .10$, $*p < .05$, $**p < .01$, $*p < .001$. Variable abbreviations: Teacher CSR = Teacher Cultural Sensitivity and Responsiveness and Math T1 = Math at Time 1.

Analysis 2: *Re-entering Control Variables*. Exploratory Analysis 2 serves as a small check as to whether I was justified in dropping all control variables in Model 3. While not definitive, re-entering all of the original Control Variables in this model allows me to see if any are significantly predictive of Growth in Mathematics Understanding (by re-running Model 3

from above after re-entering all of the controls; now called Model 5). When all of the Control Variables were re-entered into the model (Model 5; Table 17), the relations RML Status and Growth in Mathematics Understanding were weakened and became non-significant, but the patterns held, when all originally considered five control variables, Child Age, Maternal Education, Family Economic Risk, DLL Status, and Classroom Quality, were re-entered into the model (prior to RML Status). This indicates that while RMLs may generally benefit from Head Start preschool programs, the broader picture of what affects preschoolers' growth in mathematics education cannot be reduced to their RML Status alone. There are many factors that seem to contribute (however insignificantly in this sample) to children's growth in Mathematics Understanding, and based on the estimates in Model 5, it appears that DLL Status and Family Economic Risk may also be fruitful directions of investigation.

Table 17

Exploratory Analysis 2: Re-entering Control Variables

	Growth in Mathematics Understanding Unstandardized *B*(*SE*) Estimates
	Model 5 *Controls re-entered:* *Child Age, Maternal Ed,* *Economic Risk,* *DLL Status, CLASS*
Intercept	39.72* (17.20)
Child Age	-0.55** (0.16)
Maternal Ed	0.17 (1.48)

Econ Risk	1.32 (1.61)
DLL Status Yes (1)	1.23 (3.60)
CLASS	0.23 (0.43)
RML Status African-American Hispanic/Latinx	 3.53 (3.01) 2.45 (3.15)
Teacher Quality	-0.27 (0.50)
Teacher CSR	0.33 (0.41)
F-statistic	2.15†
Adjusted *R*-Squared	0.034

Note: †$p < .10$, *$p < .05$, **$p < .01$, *$p < .001$. Variable abbreviations: Econ Risk = Family Economic Risk Index, DLL Status= Dual Language Learner Status, Teach Qual = Teacher Quality, and Teach CSR = Teacher Cultural Sensitivity and Responsiveness.

Discussion

The goal of the current study was to evaluate whether or not RML status impacts mathematics understanding in Head Start preschoolers, and if so, to test whether Teacher Quality and Teacher Cultural Sensitivity Responsiveness mediate this relation. Using a large-scale dataset of a diverse group of young learners allowed for a rich analysis, reflecting the diversity of Head Start students nationally. Investigations into the current topic are timely and important as classrooms across the United States are growing to represent the cultural and linguistic diversity

of the nation, but schools are failing to keep up with the changing needs of the evolving demographic of young students in the U.S.

To test Research Question 1, the association of RML status with growth in Mathematics Understanding over the preschool year, regression analyses were conducted. First control variables were entered. In this analysis, none of the originally considered control variables, Child Age, Maternal Education, Family Economic Risk, Dual Language Learner Status, and Classroom Quality, were significant predictors of growth in Mathematics Understanding. Control Variables were dropped in the subsequent Models 2 and 3. In Model 2, RML status was added into the model as dichotomous variables representing the (non-causal) "effect" of being African American/Black and the (non-causal) "effect" of being Hispanic/Latinx. Model 2 showed that both African American/Black students and Hispanic/Latinx students grew more in their Mathematics Understanding than non-RMLs, White students. This result was consistent with my hypothesis that RML Status is related to Mathematics Understanding over the course of the preschool year.

To test Research Question 2, in Model 3, RML Status was retained as predictors for growth in Mathematics Understanding. Teacher Quality and Teacher CSR were added to test whether these composites would mediate the relationship between RML Status and growth in Mathematics Understanding during the preschool year. In the current sample, neither Teacher Quality nor Teacher CSR explained the relation between RMLs and growth in Mathematics Understanding. This result was contrary to my hypothesis that Teacher Quality and Teacher CSR mediate the relation between RML Status and growth in Mathematics Understanding.

Correlations with Demographic Variables

Child Age

Child Age was negatively correlated with Mathematics Growth. Younger Head Start preschoolers grew more in their Mathematics Understanding than older children who enrolled over the same time period. This is likely a reflection of the fact that younger children are beginning the preschool year with lower Mathematics Understanding, and since each child is receiving the same curriculum across Head Start programs, younger children are growing more in their Mathematics Understanding because they simply had more room to grow. Child Age was also related to Maternal Education which indicates that mothers with higher levels of education had children who were younger enrolled in preschool. It is possible that in this sample, mothers with higher levels of education spent more time in school completing higher levels of education before starting their families. As would be expected, Child Age was not related to Family Economic Risk, indicating that the socioeconomic condition of the household was not based on children's age. Similarly, Child Age was also not related to DLL Status, which indicated that children of all ages were DLL and non-DLLs. Child Age and CLASS were also not related which is true because the scale itself measures the classroom environment, not the student's demographics. Teacher Quality was not related to Child Age which indicates that Head Start teachers treated the older and younger children equally (as reported by their parents) in the classroom. Lastly, Child Age was not related to Teacher CSR which indicates that the level of cultural responsiveness displayed by Head Start teachers is not influenced by the age of the child in preschool.

Maternal Education

In terms of correlations among the demographic variables, as expected, Maternal Education was related with Family Economic Risk, Dual Language Learner Status, CLASS, RML status, and surprisingly correlated with Teacher CSR, which is discussed in greater detail

in the next paragraph. The association between Maternal Education and Family Economic Risk may be because mothers' level of education typically serves as an indicator of job security and income. Unsurprisingly, Maternal Education and Family Economic Risk were negatively associated as in the broader literature, and dual language learners tended to score higher on the Family Economic Risk Index. Additionally, mothers with less education tended to report their children were DLLs. This makes sense given that DLLs come from minority-language speaking households where mothers are more prone to facing issues in employment, communication, and accessibility, which may in turn limit their Educational Attainment. Preschoolers of mothers with greater educational attainment tend to be enrolled in Head Start classrooms that are more highly rated on the CLASS. Children may be enrolled in Head Start classrooms that rated highly on the CLASS because mothers with higher levels of education received training on recognizing quality indicators which helped them identify high quality Head Start classrooms prior to enrolling their children. However, because of the correlational nature of the study, we cannot infer the direction of causality between Maternal Education and Head Start classroom quality scores.

Further, Maternal Education was negatively related to RML status, which indicates that Mothers from racially minoritized backgrounds (African American/Black and Hispanic/Latinx) complete lower levels of education. This relationship is further emphasized in the literature as the United States government focuses on raising the enrollment rate of Hispanic/Latinx students in both 2-year and 4-year institutions (Kelly et al., 2011). There are systemic issues in place in our society that do not provide racially minoritized mother's an opportunity to pursue higher education (Pascarella, 1985; Smith et al., 2012). For instance, these issues are exacerbated by language barriers existing in our society without proper support in place to bridge the gap from

translation services, interpreters, and the access to utilizing such resources (Farooq & Fear, 2003).

Teacher CSR and Maternal Education. Mothers with greater educational attainment tended to rate teachers higher on Teacher CSR. This could mean that mothers who have completed higher levels of education are aware and trained to recognize culturally sensitive and responsive dialogue, interactions, and conditions in early childhood settings compared to mothers with less education. It is possible that mothers who have completed higher levels of education are more aware of and better able to advocate for their child's needs when selecting a Head Start Teacher. Alternatively, it may be the case that on average, the Head Start programs with more culturally sensitive and responsive teachers tend to be located in neighborhoods serving low-income families with mothers with relatively more education (compared to mothers in low-income neighborhoods with relatively lower education attainment).

Family Economic Risk Index

On average, the families of Dual Language Learners report greater Family Economic Risk compared to students who are English-only learners. Additionally, Family Economic Risk Index and RML status were related, indicating that RMLs, like DLLs, came from families who were at higher socioeconomic risk than their non-RML peers. The fact that being an RML, being a DLL, and greater economic risk are all correlated indicates that that while the lived experiences of RMLs are all unique, there are some commonalities among the RML experience (at least in this sample, for example, being a DLL, experiencing greater family economic risk) that should inspire future studies to consider the possible additive or multiplicative effects of multiple marginalized identities on the mathematics learning of preschoolers across the country. Further, Teacher CSR and Family Economic Risk were related such that the greater economic risk a

family experienced, the lower Teacher CSR the parents reported. Consistent with the literature, Family Economic Risk was also significantly related to Mathematics Understanding at the start of the year and marginally related to Mathematics Understanding end of the year, indicating that students from economically riskier backgrounds perform worse on mathematics compared to their (relatively) richer peers. Family Economic Risk was marginally related to Teacher Quality, which indicates that Head Start Teachers did differ their treatment to students based on their socioeconomic backgrounds.

DLL Status

Dual Language Learner Status was related to CLASS, indicating that students who were DLL Status were enrolled in classrooms that were rated highly on the CLASS. Further, there were more DLLs who identified as RML than non-RML in this sample. There was a relation between DLL Status and Teacher CSR such that Head Start Teachers were culturally sensitive towards the DLL preschoolers in their classrooms. There was a marginal relation between Mathematics Understanding at the beginning of the school year and Dual Language Learner Status, indicating that children who spoke more than one language performed poorly in mathematics upon preschool entry as compared to their monolingual peers. This finding suggests that DLL students are impacted in their mathematics understanding at the start of the academic preschool year. There was no relation to DLL Status and children's Math Understanding by the end of the year, nor was there any reported relation to the growth in their Mathematics Understanding at large.

RML Status, Teacher Quality, Teacher CSR, and Mathematics Understanding

RML Status and Teacher Quality

Analyses revealed that parents of RMLs tended to rate their children's teachers lower on Teacher Quality than parents of non-RMLs. The negative relation between RML status and Teacher Quality indicates that racially minoritized students receive lower Head Start Teacher Quality as compared to their non-RML peers. This may be the case because RMLs receive disproportionate rates of disciplinary action in early childhood education compared to their non-RML peers (Gansen, 2021; Henry et al., 2021; Okonofua et al., 2016). Further, the lack of Teacher Quality in preschool towards RMLs may contribute to the academic achievement gap as students who do not receive quality instruction do not perform as well academically (McGrady & Reynolds, 2013; Tenenbaum & Ruck, 2007).

RML Status and Teacher CSR

Additionally, parents of racially minoritized learners tended to rate their children's teachers lower on Teacher CSR compared to the parents of non-RML children. This may be the case as racially minoritized learners experience differential treatment in their early childhood experiences, which is why there is a strong push for more inclusion of linguistic and cultural diversity in the school system (Kendi, 2019; Love, 2017; Love, 2021). Additionally, this also may be the case because parents of RMLs are potentially more aware of the important areas of cultural sensitivity and responsiveness that were measured on the questionnaire for Teacher CSR, and they recognize the disparities in the treatment their children may receive in the classroom. Disparities in Teacher CSR does not help to bridge the equity gap RMLs experience in early childhood mathematics education (Ahmad & Hamm, 2013) at least in preschools with greater numbers of RMLs. If it is the case that RMLs experience less Teacher CSR on average in the broader Head Start population, this would be a major area of concern for Head Start programs, especially those serving racially minoritized learners.

Teacher Quality and Teacher CSR

I found that Head Start Teachers who were rated higher on Teacher Quality also tended to be rated higher on Teacher CSR, which makes sense as Teacher Quality and CSR are indicators of a Head Start Teacher with proper training in culturally inclusive and developmentally appropriate child practices (Aikens et al., 2020; Bowman et al., 2001; Burchinal et al., 2021). This relationship also makes sense as if parents are rating their child's Head Start Teacher has high Teacher Quality, then they must also notice the same teacher is also displaying high levels of CSR. Alternatively, this can also mean that the Head Start Teacher received adequate training to perform well in their quality and CSR. This finding aligns with the literature and our research question as Head Start Teachers demonstrating quality instruction are practicing Cultural Sensitivity and Inclusion for all learners in the classroom (D'Angelo & Dixey, 2001; Doucet & Adair, 2013).

Mathematics Understanding

As expected, Mathematics Understanding at Time 1 was correlated with both Mathematics Understanding at Time 2 and Mathematics Understanding Growth. This relationship makes sense, because students undergo formal instruction during the preschool year which provides them the foundational skills necessary to begin building their mathematical concepts (Clements et al., 2021; Kennedy & Ordell, 2014; McClure et al., 2017).

RML Status and Mathematics Understanding

RML status was negatively and significantly related to Mathematics Understanding throughout the preschool year and positively related to Mathematical Understanding Growth. Mathematics understanding across the school year being negatively related to RML status indicates the academic achievement gap persists even at the end of preschool. This result

however will be discussed further in a later paragraph. These results highlight findings in the literature regarding RML status leading to lower mathematics achievement across schools in the United States (Carter et al., 2013; Galindo et al., 2015).

Teacher Quality and Mathematics Understanding

Teacher Quality was marginally related to Mathematics Understanding at the beginning of the year, at the end of the year, and Mathematics Growth. These findings make common and theoretical sense (Vygotsky, 1978) that children's mathematics understanding would generally benefit from higher Teacher Quality. Teachers who are higher quality in this sample would be more available to their students, patient in conversations, not rude, not displaying judgements, and a figure the children can depend on. This allowed children to approach them in the classroom because they feel comfortable asking questions and seeking support, in turn bolstering their understanding. These findings also make sense on an instructional level because a Head Start Teacher who is rated highly by parents on Teacher Quality has likely received the proper training and professional development in pedagogical implementation. This may lead to better Mathematics Understanding for students throughout the preschool year.

Teacher CSR and Mathematics Understanding

Teacher CSR was positively related to Mathematics Understanding at the end of the school year, indicating that students who received high CSR had better mathematics performance at the end of the preschool year. Children who are learning in an environment where their racial identities are included in the classroom are more likely to feel a sense of belonging in education. This belongingness fosters a healthy classroom community in which learning can take place. This finding also supports Love's Abolitionist Teaching theory which highlights children learn best when they are in a classroom that acknowledges their identities and learning needs (Love,

2021). High Teacher CSR encompasses these skills which aligns it to the Abolitionist framework.

Taken together, Teacher Quality and Teacher CSR, do not support my hypothesis for Research Question 2. Research Question 2 posited that if RML Status impacts Mathematics Understanding, then Teacher Quality and Teacher CSR would mediate this relationship. This study did not find evidence to support this relationship.

Summary of Main Findings

In all the Main Analyses Models (1, 2 and 3), Model 2 highlighted how RMLs grew more in their Mathematics Understanding than non-RMLs. Lastly, Model 3 had Teacher Quality and CSR included to test whether they would mediate the relationship between RML Status and growth in Mathematics Understanding during the preschool year. Neither Teacher Quality nor Teacher CSR explained the relation between RMLs and growth in Mathematics Understanding. This contradicts what I initially predicted that both Teacher Quality and CSR would mediate the relationship between RMLs and Mathematics Understanding.

Summary of Exploratory Analyses

Exploratory Analysis 1 was a regression analysis which swapped the dependent variable from growth in Mathematics Understanding (as in the Main Analyses) to Mathematics Understanding at the end of the year. In the Main Analysis, because RMLs demonstrated significantly more growth than non-RMLs, I asked whether RMLs might also be catching up in terms of raw Mathematics Understanding at the end of the year compared to non-RMLs. Indeed, Exploratory Analysis 1 revealed that RML Status was not a significant predictor of Mathematics Understanding by the end of the year for African American/Black and Hispanic/Latinx students compared to non-RMLs. It is worth noting, that although there are differences in the raw

averages for Mathematics Understanding at Time 2, they were not statistically significant. This finding provides support for the claim that Head Start programs promote healthy development in underserved preschoolers (Choi et al., 2019; Lippard et al., 2015).

To verify whether I was justified in dropping all of the control variables (Child Age, Maternal Education, Family Economic Risk, DLL Status, and Classroom Quality) in the Main Analyses, Exploratory Analysis 2 was conducted. Upon entering all control variables into the model (Model 5; Table 17), the relationship between RML Status and growth in Mathematics Understanding weakened, indicating that the Control Variables were at least somewhat related to growth in Mathematics Understanding, though not statistically significantly. Thus, dropping the Controls from the Main Analysis seems justified based on Exploratory Analysis 2. For future studies, the field would benefit from targeted investigations which examine the necessary support and learning needs of particular groups of RMLs. Specifically, through accounting for all racial/ethnic groups (see Table 2) in addition to African American/Black and Hispanic/Latinx students, researchers can holistically represent BIPOC individuals and the factors which may influence their academic performance in subjects such as mathematics. By doing so, as a field we can work towards bridging the existing academic gap RMLs face in early childhood education.

Evidence of schools' failure to equitably serve racially minoritized learners in early childhood mathematics (Galindo & Sonnenschein, 2015; Nasir & Vakil, 2017; von Hippel et al., 2018) is not supported in this study. This current study highlights the progression school systems have made at large by RMLs slowly improving their Mathematics Understanding by the end of the preschool year, yet there is a long way to go before bridging the academic achievement gap.

Mediation and Causation

Mediation implies causation (Lange, 2012), though not always (Pearce & Vandenbroucke, 2016). However, it should be noted that it is not possible, nor is it the author's aim to assess causation with the current analysis, as the independent variable (RML status) does not allow for random assignment to groups (i.e., levels of the independent variable). Further, all possible pre-existing differences between RMLs and non-RMLs have not been "controlled for" either through matching, or another design or statistical technique. Thus, the current mediation should not be understood as causal, rather as a test of associations between constructs of interest, which while difficult to manipulate experimentally, are crucial to investigate.

Educational Implications and Future Studies

I found support for my hypothesis that RML Status impacts Mathematics Understanding over the course of the preschool year (Research Question 1). However, I did not find support for my hypothesis that Teacher Quality and Teacher CSR would mediate this relationship between RML Status and Mathematics Understanding (Research Question 2). Since Teacher Quality and Teacher CSR do not seem to mediate the relationship between RML Status and Mathematics Understanding over the course of the preschool year in this sample, what are other ways to address gaps in Mathematics Understanding?

There is great psychological significance in incorporating racial perspectives in early childhood education (Doucet & Adair, 2013; Hisle, 2022; Keiser et al., 2020). Head Start programs can benefit from trying to introduce identity interventions with students at an early age because it fosters enriching conversations around concepts of identities (Milner, 2008). By discussing identities at an early age, students are exposed to the intersectionality, polarity, and variability that can exist among populations (Park, 2011). Pulling from the Sociocultural Theory, Vygotsky (1978) highlights how the learning process children undergo in early education is

supplemented by their identities as it is the gauge which children use when navigating the learning process. In presence of a more experienced peer, such as a Head Start Teacher, children can use a holistic scope of their skillset (not just limited to academic abilities alone) to retain the lessons taught to them. These holistic skills can include their culture, heritage, languages, traditions, values, beliefs, and more. Identity as we have discussed previously includes but is not limited to race, ethnicity, language, culture, sexuality, and socioeconomic status. Pedagogical practices within the classroom however have failed to include the identities of its children, particularly cultural background, further promoting a primarily Westernized lens of teaching which disproportionately affects RMLs (Nasir & Hand, 2016; Yosso, 2006). Abolitionist Teaching can support this deficit by providing a culturally and linguistically sustaining learning environment for RMLs and non-RMLs.

Love (2020) highlights how schools can use tools of mediation to re-evaluate the information taught in lessons, availability of globally representative subjects (i.e., subjects pertaining to specific traditions, cultural practices, and histories of the underrepresented), resource accessibility, and language (i.e., providing translated materials, accessibility to a variety of languages, and culturally mindful phrasing) to combat the dominant materials that only represent Western values within social environments. Without adequate acknowledgement, the development and learning within education may be slowed or even inhibited for RMLs (Beneke & Cheatham, 2020). As our study reported RMLs perform lower in mathematics than their non-RML counterparts, the applications of Abolitionist Teaching in the Sociocultural framework are critical to the learning and success of RMLs. Abolitionist Teaching allows for students to undergo holistic revisions in their academic trajectories as Sociocultural theory emphasizes the importance of quality classroom wide interactions among students and teachers.

It is important to acknowledge and examine the experiences of racially diverse children in classrooms, as this early experience serves as a foundation for their later learning and achievement (Beneke & Cheatham, 2020; Breive, 2020; Sullivan et al., 2021). Teachers need to continue working on being available to their students, be less rude in their moment-to-moment interactions, and show cultural acceptance for student's identities and values.

The classroom needs to be a safe space for learning and development throughout the year, thus professional development training oriented around diversity, equity, and inclusion should be provided to early educators to boost their instructional tools, research, and accessibility to knowledge. To advocate for equitable learning experiences for all learners, Head Start Teachers can employ Abolitionist Teaching pedagogies in the curriculum presented preschool settings (Love, 2021). This theory provides educators with tools informed by the Critical Race Theory (Hoffman et al., 2020) and Anti-Racist Education (Kendi, 2019) to create an inclusive pedagogical lens in which student identities can be regarded (Love, 2021). Early childhood serves as a vital time for educators to highlight the significance of linguistic and cultural diversity in the classroom. Abolitionist Teaching introduces sustainable methods in which educators can facilitate conversations around race and ethnicity that supports the curriculum being taught. By promoting policies around standardizing culturally-sustaining classroom environments, teachers will be able to ensure students make progress towards their academic goals in a holistic manner. These skills will in turn benefit children as they grow up to be more informed about how identities can influence performance (Waring & Evans, 2015).

Significance of Head Start Programs

This study showed how despite RMLs falling behind in mathematics by the end of the year, they still show more improvement in their mathematics understanding compared to non-

RMLs over the course of the preschool year. This improvement supports the claim that Head Start preschool programs promote mathematics understanding in racially minoritized learners (Choi et al., 2019; Lippard et al., 2015). Students enrolled in the Head Start programs across the nation in the FACES dataset showed significant improvement in their mathematical performance by the end of the academic year. This implies that although there is an existing academic gap for RMLs, students can work towards bridging this deficit by attending Head Start programs. The Head Start preschool model provides children with a chance to explore mathematical concepts in a developmentally appropriate and enriching environment. Debs and Brown (2017) highlight how early childhood education settings are safe spaces for all children (RMLs and non-RMLs) to learn, make mistakes, and grow from these experiences. Head Start teachers work with students to support their growth and address concerns in the classroom as they arise (Aikens et al., 2017; Doran et al., 2022).

This individualized and collaborative support in the preschool classroom leads to better academic outcomes for RMLs. This study supplements the literature existing on the mathematical growth RMLs, particularly Hispanic/Latinx and African American/Black students, experience when they are in positive learning environments (Sanders et al., 2019). The Head Start preschool framework is impactful on student learning because it aligns closely with the Sociocultural and Abolitionist Teaching perspectives. This model of instruction is vital to provide all learners, including RMLS, an equitable opportunity to academic success in early childhood education. Although Teacher Quality and Teacher CSR did not mediate the relationship between RML Status and Mathematics Understanding, RMLs are still making progress in their mathematical performance by the end of the year. Sociocultural perspectives

and Abolitionist Teaching can further benefit RMLs by providing an equitable framework to approaching the mathematical curriculum (Edwards, 2003; Jenson, 2014; Love, 202).

Racially Minoritized Learners and the COVID-19 Pandemic

Adding onto this, the education system has been heavily impacted by COVID-19 (Dudovitz et al., 2021). Amid this global pandemic, instruction has morphed from distance learning, remote meetings, to hybrid instruction being reintroduced. This fluctuation in content delivery has caused learning variants and achievement gaps as teachers were not trained in the corresponding technology needed during this time, instructional methods for virtual teaching, and assessment delivery in virtual models (Pokhrel & Chhetri, 2021). Whereas prior to the Global Pandemic children may have had more exposure to numerical concepts before entering the early learning environment, this was not able to take place in distance learning because students were not able to attend classes in person (Sawchuk & Sparks, 2020). Additionally, this may be the case because household employment and regulations have shifted for the economy to account for safety regulations. Even though COVID-19 is a recent issue, many studies have already shown a disproportionate impact on communities and students of color (Dudovitz et al., 2021; Louis & King, 2022).

Conclusion

Currently, racially minoritized learners are at an educational disadvantage compared to their non-RML counterparts (Han, 2008; Louis & King, 2022). This has played a critical role in classroom dynamics as retention rates are lower for RMLs in grade school, college, and the workforce at large (Benitez, 2010; Rabiner et al., 2016). RMLs typically score lower on standardized tests and other measures of mathematics compared to non-RMLs (Clements et al., 2021). In the current study, RMLs were shown to improve in their mathematical performance

over the course of the school year. Providing RMLs a strong mathematical foundation gives them higher chances of academic success as early foundational mathematics understanding predicts adolescent mathematics achievement (Curenton et al., 2020; Watts et al., 2014). To supplement children's early numerical knowledge, enrolling in Head Start preschool programs prior to starting grade school provides them an advantage in bridging the existing academic achievement gap for RMLs. Ensuring high-quality STEM mathematics education in early childhood education not only bolsters academic performance, employment opportunities, and even quality of life for students later in life (Clements et al., 2021; Marrero et al., 2014; Simoncini & Lasen, 2018), but likely also fosters equity in professional STEM fields as a result. The results of this study can help inform future studies and classroom interventions in order to ensure a more equitable future for all learners that is culturally sustaining for RMLs and non-RMLs alike.

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