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Race/Ethnicity and Early Mathematics Skills: Relations Between Home, Classroom, and Mathematics Achievement

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ABSTRACT. This study used Early Childhood Longitudinal Study–Kindergarten Cohort data to examine influences of the home and classroom learning environments on kindergarten mathematics achievement of Black, Latino, and White children. Regardless of race/ethnicity, children who started kindergarten proficient in mathematics earned spring scores about 7–8 points higher. There was significant variability in the home and classroom learning environments of Black, Latino, and White children and associations with these children's mathematics scores. Nevertheless, reading at home was a significant predictor for spring mathematics scores for all groups. If children started kindergarten proficient in mathematics, the Latino-White mathematics gap, after controlling for home and classroom factors and other covariates, was no longer significant. However, the Black–White mathematics gap remained significant. If children did not start kindergarten proficient in mathematics, both the Latino–White and Black–White mathematics gaps remained significant.

Keywords: kindergarten, mathematics achievement, home and classroom

Racial and ethnic disparities in children's academic outcomes are a pervasive reality in U.S. schools. Black and Latino children, on average, earn lower scores than White children (e.g., Lee & Bowen, 2006; Cross, Woods, & Schweingruber, 2009). These children's lower mathematics scores are evident by the start of kindergarten or even earlier (Burchinal et al., 2011). Black children's mathematics test scores in the fall of kindergarten are about two thirds of a standard deviation lower than White children's scores (Fryer & Levitt, 2004). The White–Latino achievement gap at kindergarten entry is somewhat larger, about three quarters of a standard deviation (Reardon & Galindo, 2009).

Educational research in the past years has focused on identifying mechanisms that will help ameliorate the educational disadvantages of racial/ethnic minority children and provide appropriate educational opportunities to all. However, we still lack knowledge of the specific mechanisms for decreasing the achievement gap. Although there is an emerging literature showing the importance of young children's home and classroom learning environments for mathematics development (Crosnoe, Leventhal, et al. 2010), we do not yet know the extent to which these environments have a similar influence across racially/ethnically diverse students.

Another line of recent research has focused on the importance of children's mathematics skills at school entry. The initial mathematics skills children display predict their subsequent mathematics development (Duncan et al., 2007). However, we do not yet know whether having a strong mathematical foundation at the beginning of kindergarten is equally beneficial for children from different racial and ethnic groups. Identifying whether mathematics proficiency at kindergarten entry reduces or eliminates racial/ethnic mathematics gaps is important for designing future interventions.

This study uses data from the Early Childhood Longitudinal Study–Kindergarten Cohort (ECLS-K; National Center for Education Statistics, 2001) to examine the impact of home and classroom learning environments on children's mathematics achievement in kindergarten. We compare the performance of Black and Latino children, two groups with traditionally low mathematics scores, to that of White children (National Mathematics Advisory Panel, 2008). We also examine whether there is variability in the home and classroom learning environments of these children. Of particular interest is what home and classroom

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learning indicators, if any, are significant predictors of Black, Latino, and White children's mathematics skills? We go one step further by examining whether having a strong mathematical foundation at the beginning of kindergarten is equally beneficial for children from different racial/ethnic groups and the extent to which home and classroom environment influences are consistent between children who start kindergarten with proficient or limited mathematics skills. The study reflects suggestions by Byrnes and Wasik (2009) of the importance of investigating children's mathematics skill development within the broad context of their initial mathematics skills and learning opportunities at home and school.

Using Ecological and Sociocultural Theories to Examine Children's Mathematics Achievement

This study reflects ecological (e.g., Bronfenbrenner, 1979) and integrative theoretical models (Garcia Coll et al., 1996), which stress the need to consider interrelations among the contexts in which children develop; and sociocultural theories which stress the importance of heritage influences and the larger social structure when examining children's learning experiences and related family practices (Vygotsky, 1978; Wong & Hughes, 2006). Consistent with Bronfenbrenner's (1979) theory, we conceptualize children's learning as influenced by interactions among people within and across different contexts—in this case between children, their families, and schools. To understand children's mathematics learning, what the child brings to the task and what support systems are available at home and school must be considered. For example, Crosnoe, Leventhal, et al. (2010) found that young children's mathematics development as they transitioned into school was a function of home, preschool, and school stimulation.

We also draw from sociocultural theories that document differences in the academically relevant experiences families from different racial/ethnic groups offer their children (Garcia Coll et al., 1996). Understanding what experiences Black, Latino, and White families make available to their children is important because cultural differences can be translated into different patterns of behaviors and socialization practices (Super & Harkness, 2002). However, not all socialization practices are equally conducive to children's academic success. In a review of racial/ethnic differences in children's school readiness, Brooks-Gunn and Markman (2005) noted that Black and Latino parents talk less to their children, use a more limited vocabulary, and are less likely to read to their children than White parents. The differences in the language Black and White children hear at home can result in differences in their readiness for or understanding of instruction at school (Hindman, Skibbe, Miller, & Zimmerman, 2010). Cheadle and Amato (2011) also found that *concerted cultivation* or deliberately fostering children's cognitive skills occurred less frequently in Black and Latino families than in White families. Therefore, Black and Latino families may provide their children fewer cognitively relevant learning activities, as Bradley, Corwyn, McAdoo, and Garcia Coll (2001) found. We have not adequately researched, however, differences in the experiences of Black, Latino, and White children who start school with different levels of mathematics skills. Although children who enter school with different levels of mathematics competencies probably experienced different home learning environments, we do not yet know what specific aspects of the environment promoted mathematics development or how this may differ for these children.

Research also suggests that there are racial/ethnic differences in the relations between home and school factors and children's learning. Hill and Craft (2003) found that parents' home involvement predicted White children's mathematics achievement whereas parents' school involvement predicted Black children's mathematics achievement. Fan, Williams, and Wolters (2012) found racial/ethnic differences among Asian, Black, White, and Latino children in the effects that parental advice and communication with children's schools had on their adolescents' school motivation. Other research (Desimone, 1999; Yan & Lin, 2005) has shown similar patterns with Asian, Black, Latino, and White adolescents' academic mathematics and reading scores. However, much of this research involved a limited aspect of the home environment and included older children than the target group in this study.

Home and Classroom Influences on Kindergartners' Mathematics Development

Home learning environment. Growing up in a cognitively stimulating home predicts children's immediate and longer-term academic development (e.g., Crosnoe & Cooper, 2010; Crosnoe, Leventhal, et al. 2010). The home learning environment has been studied in different ways—as a composite of exposure to artifacts, experiences, and interactions, and as exposure to a specific variable (e.g., assistance with homework, parents' expectations). Here we consider the role of the home environment through children's participation in learning activities, parents' provision of learning tools (e.g., computers), parents' involvement at school, and expectations for their children's present and future learning. Although young children's environments may provide many opportunities for the acquisition of early mathematics skills (Ginsburg, Lee, & Boyd, 2008), we are particularly interested in documenting which experiences are most important, and whether this differs across groups of children. Accordingly, we took a broad-based approach to documenting home learning indicators (Anders et al., 2012).

Participation in home learning activities. Our knowledge of what specific home-based activities foster children's mathematics skills is still fairly limited. However, we know that playing mathematics-related board and card games and helping with cooking and shopping positively predicts numeracy skills (LeFevre et al., 2009**;** Ramani & Siegler, 2008).

A recent line of research has shown the relation between children's language skills and mathematics development (e.g., Jordan, Huttenlocher, & Levine, 1994; Lopez, Gallimore, Garnier, & Reese, 2007). Relatedly, Davis-Kean (2005) found that the frequency of engagement in reading predicted the reading and mathematics skills of Black and Latino children 8–12 years old. Engaging in reading activities increases children's vocabulary, which improves their understanding of the instructional language teachers use when teaching mathematics (e.g., Hindman et al., 2010; Sénéchal & LeFevre, 2002; Sonnenschein, Thompson, Metzger, & Baker, 2013). Accordingly, we documented children's reading learning activities (frequency with which the child looked at book alone or with others).

We also documented general learning activities which included a range of activities (e.g., play games or do puzzles, talk about nature or do science projects), available through daily or recurrent experiences at home, which may broaden a child's general knowledge and, hence, mathematics knowledge (Ginsburg et al., 2008).

Learning tools. Crosnoe and Cooper (2010), using the ECLS-K data set, found that children who had access to cognitively stimulating materials or learning tools (e.g., computers) had higher mathematics and reading scores; access to such materials at home mediated the association between economic disadvantage and achievement. Bradley et al. (2001), using the National Longitudinal Study of Youth data set, found that Black and Latino children of kindergarten age had less access to learning tools than White children. Accordingly, we documented the books, CDs, records, or tapes in the home and whether the child had a computer.

Parents' involvement at school. Parents' involvement at school, regardless of their racial/ethnic group, is associated with children's academic development (e.g., Galindo & Sheldon, 2011; Lee & Bowen, 2006). Galindo and Sheldon (2011) found that parents' involvement at school positively predicted growth in children's mathematics scores in kindergarten. Lee and Bowen (2006) found that involvement at school significantly predicted Black, Latino, and White third- through fifth-grade students' academic competencies. However, Black and Latino parents are less involved in their children's schools than are White middle-income parents (Floyd, 1998; Lee & Bowen, 2006). We documented whether parents attended various school events, volunteered at the school or in the classroom, and met with the teacher.

Parents' expectations for their children's present and future learning. Parents' expectations for their children's academic progress and achievement serve as an indicator of the family norms and values associated with schooling (Galindo & Sheldon, 2011; Jeynes, 2005). There are differences, however, across racial/ethnic groups in the expectations parents have for their children (Suizzo & Stapleton, 2007), and in the relation between parents' expectations and children's achievement (Yamamoto & Holloway, 2010). Suizzo and Stapleton (2007), after controlling for mother's educational level, found that Black and Latino mothers of kindergartners expressed higher educational expectations than White mothers. Yamamoto and Holloway (2010) suggested that the relation between parents' educational expectations and children's educational outcomes is stronger for White children than racial/ethnic minorities. They proposed that such relations are mediated by children's motivation and sense of competency, parents' involvement, and teachers' expectations, and the relations may differ among racial/ethnic groups.

This study explores parents' expectations in two ways. We document parents' future educational expectations, a metric commonly used by others (Jeynes, 2005) that assesses the highest educational level parents expect their children to attain. We also consider present expectations, what skills parents expect their children to display in kindergarten. This more proximal measure may have stronger relations with present parent–child interactions and, therefore, with children's achievement.

Classroom Learning Environment

Although research has considered aspects of schooling and racial/ethnic issues (Carter, 2003; Parke & Kanyongo, 2012; Yonezawa, Wells, & Serna, 2002), there is little research investigating differences in classroom practices across racial/ethnic or other demographic groups (Chang, 2008). Existing research has focused mainly on children with different language backgrounds and supports the need for further investigation (Chang, 2008; Valle, Diaz, Waxman, & Padron, 2013). In this study we investigate the amount of mathematics instruction, the type of mathematics instruction, and the classroom composition.

Amount of mathematics instruction. The amount of mathematics instruction children receive is related to their mathematics skills (e.g., Guarino, Hamilton, Lockwood, & Rathbun, 2006; Magnuson, Ruhm, & Waldfogel, 2007). Bodovski and Farkas (2007) found that the Black–White mathematics achievement gap was smaller in full- than half-day kindergarten classes. They attributed the differences to children receiving more mathematics instruction in full-day classes. We documented the amount of time teachers reported teachers reported children spent doing mathematics.

Mathematics instructional practices. Educators and researchers stress the importance of children's foundational knowledge in mathematics for their future development (Cross et al., 2009). Kindergartners need to begin to acquire computational proficiency and conceptual understanding of mathematics (National Mathematics Advisory Panel, 2008), including counting and cardinality, operations and algebraic thinking, measurement and data, and geometry (http://www.corestandards.org). Although children need to use such knowledge to begin to problem solve and reason mathematically, how to best acquire it is less clear.

Crosnoe, Morrison, et al. (2010) found that instruction that required children to make inferences narrowed the achievement gap between children with more limited mathematics skills and those with greater mathematics skills. Bodovski and Farkas (2007) and Guarino et al. (2006) included teachers' instructional approaches and the content of their instruction to document the effects of mathematics instruction on kindergarten children. Bodovski and Farkas found that instruction that focused on age-appropriate but higher level skills positively predicted Black but not Latino children's mathematics scores. Guarino et al. found that student-centered instruction (emphasizing students taking an active role in their learning), traditional practices and computations (emphasizing computation facility using fairly traditional didactic methods such as worksheets), measurement and advanced topics (reading simple graphs, telling time, estimating probability, using measurement tools), and advanced numbers and operations (counting by twos, fives, and tens, counting beyond 100, reading two- and three-digit numbers, place values) predicted gains in kindergartners' mathematics skills. We use Guarino et al.'s system in this study.

Classroom composition. The importance of compositional effects at the school and classroom levels is well-documented (Coleman et al., 1966). Children in schools with a lower concentration of minority children or with a larger concentration of high socioeconomic status (SES) students have higher test scores (Aikens & Barbarin, 2008; Ready & Silander, 2011). Hoxby (2000) found that the achievement level of their classroom peers affected individual children's achievement. Relatedly, Hanushek, Kain, Markman, and Rivkin (2003) found comparable positive effects of classroom achievement levels on the achievement of children at different levels of the achievement distribution. Accordingly, we investigated whether the percentage of children with proficient mathematics skills influenced children's mathematics skills and whether this varied with children's race/ethnicity and mathematics proficiency level.

The Present Study

This study is motivated by three sets of findings pertinent for understanding Black/Latino and White mathematics achievement gaps. One, although early mathematics skills are important predictors of children's subsequent mathematics development (Duncan et al., 2007), we do not yet know whether they are equally predictive for Black, Latino, and White children. Such knowledge is important for designing effective interventions. Two, although there are differences in the home learning environments of children from different racial/ethnic backgrounds (Brooks-Gunn & Markman, 2005), we do not know which aspects of the environment are relevant for demographically diverse children who start kindergarten with different mathematics skills. Three, although there are differences in the impact of home factors on children from different ethnic/racial backgrounds (e.g., Desimone, 1999), research has focused mainly on older children and has not considered potential differential impact based on children's mathematics skills at school entry.

This study addresses the limitations in prior research by considering race/ethnicity and initial mathematics skills and by investigating in greater detail than is typically done indicators of the home and classroom learning environments. This study documents the mathematics achievement during kindergarten of Black, Latino, and White children, divided into those displaying proficiency and limited proficiency in mathematics at the start of kindergarten. We investigated three questions.

Research Question 1: To what extent are there differences in these children's home and classroom learning environments?

Research Question 2: What are the relations between these children's home and classroom learning environments, documented in kindergarten, and their mathematics achievement?

Research Question 3: Are the relations between variables comprising the home and classroom learning environments consistent between Black, Latino, and White children who start kindergarten with proficient or limited mathematics skills?

Method

Sample

The data came from the ECLS-K of 1998–1999 which included a nationally representative sample of about 21,000 kindergarteners in over 1,000 schools (National Center for Educational Statistics, 2001). We used the kindergarten cohort sample and limited it to Black, Latino, and White children with available mathematics test scores in the spring and fall of kindergarten and available data on key predictors.

After using listwise deletion, the analytical sample included 12,610 children from 2,645 classrooms in 928 schools, which is 67% of the base sample (i.e., kindergarten cohort after excluding Asians and children from other ethnic/racial groups). Listwise deletion of cases is a popular technique to deal with missing data, especially when working with large data sets where losing power is not a concern (Allison, 2001).

There were some statistically significant differences between the analytical and excluded samples in some demographic characteristics (i.e., race/ethnicity and SES) and home and classroom learning environments. There was a lower concentration of racial/ethnic minority and low SES children in the analytical sample (15% were Black, 19% were Latino, mean SES was 0.05) than in the excluded sample (21% were Black, 25% were Latino, mean SES was −0.14). Children in the analytical sample on average had a greater number of learning tools, greater participation in reading and general learning activities, and higher levels of parents' involvement in schools than those in the excluded sample. Also, children in the analytical sample received less overall mathematics instruction, traditional practices and computation, and mixed and student-centered instruction and were enrolled in classrooms with a greater concentration of proficient children than children excluded. No differences between these two samples were found on their present and future educational expectations. The differences observed between the analytical and excluded samples, although small, should be considered when examining the results of the study. Given that the excluded sample showed disadvantages in several of the key indicators analyzed, it is plausible that the associations observed in this study would have been stronger if more disadvantaged students were included.

Measures

Mathematics achievement. Mathematics achievement was measured using individually administered two-stage adaptive mathematics tests, with content areas and domains based on the National Assessment of Educational Progress framework (National Center for Education Statistics, 2001). These measured number sense, properties, and operations; measurement; geometry and spatial sense; data analysis, statistics, and probabilities; and patterns, algebra, and functions. We used item response theory (IRT) scale scores to measure mathematics achievement in the spring of kindergarten. The IRT mathematics scale scores are criterion-referenced measures of achievement that place children's performance within a common and continuous 64-point scale. For more details on the ECLS-K assessments see Rock and Pollack (2002).

Race/Ethnicity. Children were classified as White, not Hispanic; Black, not Hispanic; Hispanic, any race; Asian; and other race. We limited our sample to White, Black, and Latino children. About 15% of the children in this study were Black, 20% were Latino, and 66% were White.

Mathematics proficiency at kindergarten entry. We used mathematics proficiency level scores at kindergarten entry to categorize children as displaying proficient or limited proficiency mathematics skills. Children were considered to display mathematics proficiency if they obtained a proficient probability of 0.75 or higher on tasks such as counting beyond 10, recognizing patterns, and comparing objects' sizes. These tasks, components of number sense, correspond to the second proficiency level—relative size, measured by the ECLS-K mathematics assessments. Skills measured in this proficiency level are consistent with the skills Jordan and colleagues (Jordan, Kaplan, Olah, & Locuniak, 2006; Jordan, Kaplan, Ramineni, & Locuniak, 2009) used to measure number sense, which is highly predictive of later mathematics achievement. About 27% of the Black, 28% of the Latino, and 56% of the White children began kindergarten with proficient mathematical skills.

Learning Environments

Home learning environment was measured using general learning and reading learning activities, access to learning tools, parents' involvement in school, and parents' future and present educational expectations.

General home learning activities. This was the average of parents' responses to two questions. Parents reported using a 4-point Likert-type scale ranging from 1 (*never*) to 4 (*every day*) how often they or other family members participated in the following activities with their child: tell stories, sing songs, do arts, do chores, play games or do puzzles, talk about nature or do science projects, play sports and build things together, or play with construction toys. Parents also reported whether (0 = no, 1 = yes) the child participated in dance lessons, athletic events, organized clubs, music lessons, drama classes, art lessons, organized performing, craft classes, and non-English language instruction outside of school hours. Responses to items within each question were standardized and then averaged. The Cronbach's alpha was .62, somewhat lower than optimal. However, we do not necessarily expect different components of this scale, or others discussed subsequently, to be highly interrelated.

Reading home learning activities. We averaged responses to three questions the frequency (1 = *never* to 4 = *everyday*) with which children looked at picture books and read books by themselves or with others. Cronbach's alpha was .63.

Learning tools. This index consisted of number of books and number of CDs, records, and tapes in the home, and whether the child had a computer. The first two questions were open-ended; the third question was dichotomous. Therefore, responses to the items were standardized and then averaged to create a composite measure. Cronbach's alpha for this index was .58.

Parents' involvement in school. Parents reported whether they attended or participated (0 = no, 1 = yes) in various school-related events: open house or back-to-school nights; meetings of parent–teacher association, parent–teacher organization, or parent–teacher–student organization; meetings of the parent advisory group or policy council; regularly scheduled parent–teacher conferences or meeting with teachers; school or class events; volunteering at the school or serving on a committee; and fundraising for the school. Cronbach's alpha was .58.

Parents' future educational expectations. Parents were asked what level of educational attainment they believed their child would achieve. Response options ranged from 1 (*receive less than a high school diploma*) to 6 (*get a PhD, MD, or other higher degree*).

Parents' present educational expectations. Parents were asked to rate how important (1 = *not important* to 5 = *essential*) it was for their child to have certain competencies to be ready for kindergarten: knowing how to count to 20 or more, sharing and taking turns, using pencils and paint brushes, knowing alphabet letters, communicating well, and sitting still and paying attention. Cronbach's alpha was .77.

Classroom learning environment was measured by amount of mathematics instruction, type of mathematics instruction, and classroom composition.

Amount of mathematics instruction. Teachers were asked, "How much time do children in your class(es) usually work on lessons or projects in mathematics, whether as a whole class, in small groups, or in individualized arrangements?" Response options were 1 (1–30 min), 2 (31–60 min), 3 (61–90 min), or 4 (more than 90 min).

Mathematics instructional practices. We adopted the procedure used by Guarino et al. (2006) for creating these variables. Teachers responded to two questions about their pedagogical approaches to teaching mathematics. They rated the frequency (1 = *never* to 6 = *daily*) with which they used different activities in the classroom, including working with geometric manipulatives, playing mathematics-related games, using music or creative movements to understand concepts, explaining mathematics problems, solving mathematics problems in group or with a partner, solving real-life problems, working in mixed achievement groups, and engaging in peer tutoring. Teachers also indicated how often they taught mathematics skills (e.g., recognizing fractions, writing numbers 1–100, estimating probabilities). Response options included "taught at a higher level," "children should already know," or the frequency with which the skill was taught (from once a month to daily). Only the frequency choices were used to calculate scores; the other two response choices were assumed to indicate that the skills were not taught at that time.

We combined responses to create six scales: numbers and geometry (11 items, Cronbach's $\alpha = .83$), advanced numbers and operations (five items, Cronbach's $\alpha = .75$), traditional practices and computation (seven items, Cronbach's $\alpha = .72$), student-centered mathematics (six items, Cronbach's $\alpha = .74$), mixed-achievement grouping (two items, Cronbach's $\alpha = .55$), and measurement and advanced topics (nine items, Cronbach's $\alpha = .80$).

Classroom mathematics proficiency composition. We averaged the number of children per classroom who were proficient in mathematics at kindergarten entry.

Control Variables

Child-level control variables were mathematics assessment dates, children's approaches to learning (based on teachers reports on a frequency scale for behaviors such as task persistence, attentiveness, eagerness to learn, and learning independence), gender, age at kindergarten entry in months, whether the child repeated any grade, type of nonparental child care measured by four dummy variables (participation in center-based, home-based, Head Start, or other type of care). Family-level controls were SES (composite of the educational attainment and occupation of parents and family income), single-parent family, whether English is the primary home language, and a crowded household (children with four or more siblings at homes). School level controls were the socioeconomic composition of the student body, and whether the school was public or private. These control variables were included in all regression models examining the associations between children's learning environments and mathematics achievement in the spring of kindergarten.

Analytic Plan

All statistical analyses were estimated using Stata 12 (StataCorp., College Station, TX) *survey commands* specifying stratification levels, sampling units, and sampling weights to take into account the complex cluster sample design and nesting structure of the ECLS-K data. Thus, these commands addressed potential concerns about the nesting of the data (students within classrooms within schools).

We estimated mean IRT scores for the fall and spring of kindergarten to describe mathematics achievement of Black, Latino, and White children who started kindergarten proficient or not proficient in mathematics. We also reported achievement differences across groups in standard deviation units, after dividing students' scores by the pooled standard deviation in the fall and spring of kindergarten (Reardon & Galindo, 2009). A score of zero corresponded to the average score for the reference group, White children who were mathematics proficient at kindergarten entry. Thus, we reported relative achievement differences—relative to the amount of variation in test scores within each group—adjusted only for differences in time of assessment.

To study children's home and classroom learning environments, we estimated descriptive (unadjusted) statistics of the main learning variables. *Lincom*, a postestimation command commonly use to estimate t tests with survey data, tested whether mean differences in key variables were statistically significant across racial/ethnic groups. Because we conducted multiple group comparisons simultaneously, it is possible to have an increased probability of Type I error. Therefore, we used the Bonferroni correction. We decreased the alpha levels of our comparison analyses to .016 (.05 divided by 3; given that we compared mean differences across 3 racial/ethnic groups). Results in the tables are reported in unstandardized metric. Effect sizes, calculated with Cohen's d (Cohen, 1988), are included in the text.

To analyze whether children's learning environments were associated with mathematics achievement in the spring of kindergarten, we estimated five regression models. Models 1–3 report relations between home and classroom learning environments and children's mathematics skills, run separately for each racial/ethnic group. Models 4 and 5 show associations between home and classroom learning environments and mathematics achievement of children who started kindergarten with proficient or limited mathematics skills. All models included the same independent and key control variables (control variable coefficients are not reported in tables).

There are two different methods for examining whether patterns of associations between variables differ across groups: Interaction effects and estimation of separate models. After careful consideration, we decided to estimate separate models for Black, Latino, and White children and for proficient and nonproficient children to analyze the extent to which the associations between home and classroom learning environments and mathematics achievement varied across groups. Our decision to use separate models is based, in part, on Clogg, Petkova, and Haritou (1995) and others who have argued that interaction effects should not be used for group comparisons when the error variance across groups is not the same. The residual variances across Black, Latino, and White children in the present sample were not the same in either the unadjusted or full models (differences in mean variances or residual variances were tested using *robvar* command). Another reason why models with interaction effects may negatively impact the validity of the estimates is that interaction terms are not linear, and therefore violate one of the key assumptions of ordinary least squares regression (Jaccard, Wan, & Turrisi, 1990; Robinson & Schumacker, 2009).

Results

Children's Mathematics Achievement in Kindergarten

Table 1 presents children's mean mathematics scores in the fall and spring of kindergarten as well as standardized gaps. Mathematics scores of children in each group significantly improved from fall to spring (Black proficient: $d = 1.45$; Black nonproficient: $d = 1.53$; Latino proficient: $d = 1.43$; Latino nonproficient: $d = 1.63$; White proficient: $d = 1.25$; White nonproficient: $d = 1.87$). Nevertheless, the magnitudes of the changes between the fall and spring were larger for children who started kindergarten with limited mathematics skills.

TABLE 1. Kindergarten Mathematics Achievement by Race/Ethnicity and Mathematics Proficiency at Kindergarten Entry

	Unstandardized means				Standardized mean difference			
	Fall kindergarten		Spring kindergarten		Fall kindergarten		Spring kindergarten	
	M	*SD*	*M*	*SD*	*M*	*SE*	*M*	*SE*
Black children proficient ($n = 510$)	23.88	4.05	31.26	5.95	−0.38	0.04	−0.44	0.04
Black children nonproficient ($n = 1,350$)	14.43	3.03	21.30	5.59	−1.78	0.04	−1.65	0.04
Latino children proficient ($n = 680$)	25.02	5.04	33.44	6.60	−0.207	0.04	−0.18	0.04
Latino children nonproficient ($n = 1,750$)	13.85	3.19	21.55	5.87	−1.87	0.02	−1.63	0.03
White children nonproficient ($n = 3,680$)	15.59	2.89	24.09	5.75	−1.61	0.02	−1.31	0.02
White children proficient ($n = 4,640$)	26.42	6.10	34.86	7.36	—	—	—	—

Note. All means and gaps were estimated using Stata *survey command*, including Early Childhood Longitudinal Study–Kindergarten Cohort weights. Reference group (in parentheses) was White children proficient. All unweighted sample sizes were rounded to the nearest 10 because of restricted license requirements. All changes in mathematics item response theory scores between fall and spring were statistically significant at $p \leq .001$. All achievement gaps were statistically significant at $p \leq .001$.

Another way to consider differences in children's mathematics scores is to compare the scores of the Black, Latino, and White children with different levels of mathematics proficiency to those of the reference group, White proficient children. Children in each of the five comparison groups scored lower than White proficient children in the fall and spring of kindergarten. As expected, much larger differences were observed for children who started kindergarten with limited mathematics skills than for proficient. Nevertheless, White proficient children earned significantly higher scores than either Black or Latino proficient children.

Children's Home Learning Environments

There was significant variability in the home learning environments of Black, Latino, and White children. White children generally earned higher scores than Black and Latino children on all indices except for parents' present and future expectations (Table 2).

White children had higher scores on reading ($d = 0.18$) and general learning activities ($d = 0.27$), learning tools ($d = 1.01$), and higher levels of parents' involvement in schools ($d = 0.62$) than Black children. White children also had a greater number of reading ($d = 0.24$) and general learning activities ($d = 0.44$), learning tools ($d = 0.91$), and higher levels of parents' involvement in schools ($d = 0.48$) than Latino children. In contrast to the prior patterns favoring White children, parents of Black and Latino children reported higher future ($d = 0.18$ and $d = 0.35$, respectively) and present educational expectations ($d = 0.26$ and $d = 0.08$, respectively) than parents of White children.

There also were important differences between Black and Latino children in indicators of the home learning environments. Black parents reported that their children had higher exposure to general learning activities ($d = 0.18$) and had higher present educational expectations for their children ($d = 0.20$). In contrast, Latino parents reported higher levels of parent

TABLE 2. Descriptive Statistics for Children's Home Learning Environments by Race/Ethnicity and Mathematics Proficiency at Kindergarten Entry

	Black		Latino		White	
	M	95% CI	M	95% CI	M	95% CI
Across proficiency levels						
Reading learning activities	3.17^{c} (0.63)	[3.14, 3.21]	3.13^{c} (0.66)	[3.10, 3.17]	$3.28^{a,b}$ (0.60)	[3.26, 3.30]
General learning activities	$-0.06^{b,c}$ (0.38)	[−0.08, −0.03]	$-0.13^{a,c}$ (0.39)	[−0.15, −0.10]	$0.05^{a,b}$ (0.39)	[0.05, 0.07]
Learning tools	-0.40^{c} (0.58)	[−0.44, −0.37]	-0.36^{c} (0.64)	[−0.40, −0.32]	$0.25^{a,b}$ (0.70)	[0.22, 0.27]
Parents' involvement in school	$0.45^{b,c}$ (0.25)	[0.43, 0.47]	$0.48^{a,c}$ (0.23)	[0.47, 0.50]	$0.59^{a,b}$ (0.21)	[0.58, 0.60]
Parents' future educational expectations	$4.16^{b,c}$ (1.23)	[4.08, 4.24]	$4.35^{a,c}$ (1.22)	[4.29, 4.41]	$3.96^{a,b}$ (1.02)	[3.92, 3.99]
Parents' present educational expectations	$4.11^{b,c}$ (0.42)	[4.09, 4.13]	$4.03^{a,c}$ (0.43)	[4.01, 4.04]	$3.99^{a,b}$ (0.53)	[3.97, 4.00]
Proficient in mathematics at kindergarten entry						
Reading learning activities	3.27^{c} (0.59)	[3.21, 3.32]	3.31 (0.62)	[3.25, 3.360]	3.36^{a} (0.58)	[3.33, 3.37]
General learning activities	-0.00^{c} (0.38)	[−0.04, 0.04]	0.01^{c} (0.41)	[−0.02, 0.05]	$0.12^{a,b}$ (0.41)	[0.10, 0.13]
Learning tools	$-0.22^{b,c}$ (0.62)	[−0.28, −0.16]	$0.014^{a,c}$ (0.72)	[−0.05, 0.08]	$0.38^{a,b}$ (0.68)	[0.35, 0.40]
Involvement in school	$0.51^{b,c}$ (0.24)	[0.48, 0.54]	$0.56^{a,c}$ (0.21)	[0.54, 0.58]	$0.63^{a,b}$ (0.21)	[0.62, 0.63]
Future educational expectations	4.43^{c} (1.18)	[4.29, 4.56]	4.44^{c} (1.08)	[4.35, 4.53]	$4.12^{a,b}$ (0.92)	[4.08, 4.15]
Present educational expectations	$4.19^{b,,c}$ (0.46)	[4.14, 4.24]	$4.08^{a,c}$ (0.48)	[4.04, 4.12]	$4.02^{a,b}$ (0.54)	[4.00, 4.04]
Not proficient in mathematics at kindergarten entry						
Reading learning activities	$3.14^{b,c}$ (0.64)	[3.10, 3.17]	$3.07^{a,c}$ (0.66)	[3.032, 3.109]	$3.19^{a,b}$ (0.61)	[3.17, 3.22]
General learning activities	$-0.08^{b,c}$ (0.37)	[−0.10, −0.05]	$-0.18^{a,c}$ (0.38)	[−0.198, −0.153]	$-0.01^{a,b}$ (0.35)	[−0.03, 0.00]
Learning tools	-0.47^{c} (0.46)	[−0.51, −0.43]	-0.49^{c} (0.56)	[−0.530, −0.455]	$0.10^{a,b}$ (0.69)	[0.07, 0.13]
Parents' involvement in school	$0.42^{b,c}$ (0.24)	[0.40, 0.44]	$0.46^{a,c}$ (0.23)	[0.442, 0.473]	$0.55^{a,b}$ (0.21)	[0.54, 0.56]
Parents' future educational expectations	$4.06^{b,c}$ (1.23)	[3.97, 4.15]	$4.31^{a,c}$ (1.26)	[4.240, 4.384]	$3.76^{a,b}$ (1.07)	[3.72, 3.81]
Parents' present educational expectations	$4.08^{b,c}$ (0.40)	[4.05, 4.11]	$4.01^{a,c}$ (0.40)	[3.983, 4.023]	$3.95^{a,b}$ (0.51)	[3.93, 3.97]

Note. Standard deviations are in parentheses. Between-group differences significant at the 0.016 level (or lower) are specified as statistically significant from: (a) Black children, (b) Latino children, and (c) White children. All statistics were estimated using Stata *survey command*, including Early Childhood Longitudinal Study–Kindergarten Cohort weights.

involvement in schools ($d = 0.16$) and higher future educational expectations ($d = 0.15$).

The patterns of racial/ethnic differences did not change much when examining the home learning environments separately by mathematics proficiency. Among children who started kindergarten with proficient mathematics skills, White children had higher scores on reading ($d = 0.17$) and general learning activities ($d = 0.29$), learning tools ($d = 0.92$), and higher levels of parents' involvement in schools ($d = 0.51$) than Black children. White children also had higher scores on general learning activities ($d = 0.25$), learning tools ($d = 0.52$), and higher levels of parents' involvement in schools ($d = 0.31$) than Latino children. Latinos had higher scores on learning tools ($d = 0.35$) and parents' involvement in schools ($d = 0.21$) than Blacks.

Among children who started kindergarten with limited mathematics skills, White children had higher scores on reading ($d = 0.09$, $d = 0.19$) and general learning activities ($d = 0.18$, $d = 0.45$), learning tools ($d = 0.96$, $d = 0.94$), and higher levels of parents' involvement in schools ($d = 0.55$, $d = 0.41$) than Black or Latino children.

Recall that contrary to other components of the home learning environment, White children had lower scores on future and present expectations than Black children and Latino children. Similar patterns of findings were observed when children were separated by levels of mathematics proficiency. Parents of Black and Latino children with proficient mathematics skills again reported higher future ($d = 0.29$, $d = 0.32$), and present expectations ($d = 0.34$, $d = 0.12$) than White children. Similar patterns were found for children with limited mathematics skills (Black children: $d = 0.26$ and $d = 0.29$, Latino children: $d = 0.47$ and $d = 0.13$, for future and present expectations, respectively).

Children's Classroom Learning Environments

There was significant variability in the classroom learning environments across racial/ethnic groups. White children generally received lower scores than Black and Latino children on all indices except for the average proficiency level of the class (Table 3).

White children reportedly received less mathematics instruction ($d = 0.20$, $d = 0.15$), less instruction in numbers and geometry ($d = 0.25$, $d = 0.17$) and traditional practices and computation ($d = 0.45$, $d = 0.15$), and less student-centered mathematics instruction ($d = 0.34$, $d = 0.18$) and mixed achievement grouping ($d = 0.18$, $d = 0.17$) than Black or Latino children. In contrast, White children attended mathematics classes where the average mathematics proficiency of their classmates was higher than that of Black ($d = 0.82$), or Latino children ($d = 0.80$). White children were far more likely than Black or Latino children to attend mathematics classes with a higher percentage of children who were proficient in mathematics. There were only two aspects of the classroom learning environment where there were significant differences between Blacks and Latinos. Blacks received significantly more traditional practices and computations ($d = 0.30$), and student-centered mathematics instruction ($d = 0.15$).

Among children who started kindergarten with proficient mathematics skills, White children reportedly received less instruction in numbers and geometry ($d = 0.20$) and traditional practices and computation ($d = 0.48$), and less student-centered mathematics instruction ($d = 0.37$) and mixed achievement grouping ($d = 0.18$), and measurement and advanced topics ($d = 0.19$) than Black children (Table 3). White children also received less instruction in traditional practices and computation ($d = 0.16$), and less student-centered mathematics instruction ($d = 0.15$), than Latino children. In contrast, White children attended mathematics classes where the average mathematics proficiency of their classmates was higher than that of Black ($d = 0.54$), or Latino children ($d = 0.29$).

Patterns among children who started kindergarten with limited proficiency in mathematics were similar to their peers with proficient mathematics skills with one exception, the amount of mathematics instruction. White children reportedly received less mathematics instruction ($d = 0.23$), less instruction in numbers and geometry ($d = 0.27$) and traditional practices and computation ($d = 0.46$), and less student-centered mathematics instruction ($d = 0.34$) and mixed achievement grouping ($d = 0.18$) than Black children. White children also received less mathematics instruction ($d = 0.18$) less instruction in numbers and geometry ($d = 0.20$) and traditional practices and computation ($d = 0.17$), and less student-centered mathematics instruction ($d = 0.21$), and mixed achievement grouping ($d = 0.21$) than Latino children. In contrast, White children attended mathematics classes where the average mathematics proficiency of their classmates was higher than that of Black ($d = 0.65$) or Latino children ($d = 0.74$).

Relations Between Home and Classroom Learning Environments and Children's Mathematics

There were commonalities as well as variability across racial/ethnic groups in associations between home and classroom learning indicators and children's spring mathematics skills (Table 4). Within the home learning environment, reading activities and parents' present educational expectations were significantly associated with mathematics achievement in the spring for Black, Latino, and White children. For Black and White children, learning tools and parents' future educational expectations were also significantly associated with mathematics scores. There also was a significant association between general learning activities and mathematics scores for White children.

TABLE 3. Descriptive Statistics for Children's Classroom Learning Environments by Race/Ethnicity and Mathematics Proficiency at Kindergarten Entry

	Black		Latino		White	
	M	95% CI	M	95% CI	M	95% CI
Across proficiency levels						
Amount of mathematics instruction	1.90[c] (0.72)	[1.82, 1.98]	1.87[c] (0.72)	[1.80, 1.92]	1.75[a,b] (0.74)	[1.71, 1.80]
Numbers & geometry	4.55[c] (0.67)	[4.47, 4.62]	4.50[c] (0.69)	[4.44, 4.55]	4.38[a,b] (0.72)	[4.33, 4.42]
Advanced number & operations	3.45 (1.31)	[3.32, 3.58]	3.52 (1.34)	[3.39, 3.66]	3.45 (1.13)	[3.35, 3.54]
Traditional practices & computation	3.45[b,c] (0.98)	[3.33, 3.57]	3.16[a,c] (0.94)	[3.08, 3.24]	3.02[a,b] (0.95)	[2.96, 3.09]
Student-centered mathematics instruction	3.71[b,c] (0.91)	[3.62, 3.80]	3.57[a,c] (0.92)	[3.50, 3.64]	3.41[a,b] (0 91)	[3.35, 3.46]
Mixed-achievement grouping	3.73[c] (1.47)	[3.58, 3.88]	3.71[c] (1.38)	[3.61, 3.81]	3.46[a,b] (1.50)	[3.37, 3.56]
Measurement & advanced topics	2.77 (0.83)	[2.68, 2.86]	2.71 (0.83)	[2.64, 2.78]	2.68 (0.80)	[2.63, 2.74]
Average proficiency level	0.30[c] (0.25)	[0.28, 0.33]	0.30[c] (0.27)	[0.28, 0.32]	0.51[a,b] (0.27)	[0.50, 0.53]
Proficient in mathematics at kindergarten entry						
Amount of mathematics instruction	1.85 (0.71)	[1.74, 1.95]	1.83 (0.73)	[1.75, 1.91]	1.76 (0.74)	[1.71, 1.81]
Numbers & geometry	4.52[c] (0.69)	[4.42, 4.62]	4.45 (0.70)	[4.37, 4.53]	4.38[a] (0.75)	[4.33, 4.43]
Advanced number & operations	3.56 (1.23)	[3.41, 3.71]	3.597 (1.33)	[3.43, 3.76]	3.54 (1.35)	[3.44, 3.64]
Traditional practices & computation	3.52[b,c] (0.99)	[3.37, 3.67]	3.21[a,c] (1.01)	[3.09, 3.33]	3.05[a,b] (0.96)	[2.98, 3.12]
Student-centered mathematics instruction	3.76[b,c] (0.90)	[3.64, 3.89]	3.56[a,c] (0.93)	[3.46, 3.67]	3.42[a,b] (0.93)	[3.35, 3.48]
Mixed-achievement grouping	3.75[c] (1.47)	[3.53, 3.96]	3.58 (1.52)	[3.44, 3.73]	3.47[a] (1.53)	[3.36, 3.58]
Measurement & advanced topics	2.88 (0.83)	[2.75, 3.00]	2.74 (0.83)	[2.65, 2.83]	2.72 (0.82)	[2.66, 2.78]
Average proficiency level	0.51[b,c] (0.24)	[0.48, 0.54]	0.57[a,c] (0.24)	[0.54, 0.60]	0.64[a,b] (0.23)	[0.62, 0.65]
Not proficient in mathematics at kindergarten entry						
Amount of mathematics instruction	1.92[c] (0.72)	[1.83, 2.00]	1.88[c] (0.72)	[1.81, 1.95]	1.75[a,b] (0.74)	[1.70, 1.80]
Numbers & geometry	4.56[c] (0.66)	[4.48, 4.64]	4.51[c] (0.68)	[4.45, 4.58]	4.37[a,b] (0.69)	[4.32, 4.42]
Advanced number & operations	3.41 (1.33)	[3.26, 3.55]	3.50 (1.34)	[3.35, 3.65]	3.33 (1.31)	[3.23, 3.44]
Traditional practices & computation	3.43[b,c] (0.98)	[3.30, 3.56]	3.15[a,c] (0.92)	[3.06, 3.23]	2.99[a,b] (0.94)	[2.92, 3.06]
Student-centered mathematics instruction	3.69[c] (0.91)	[3.60, 3.79]	3.58[c] (0.92)	[3.50, 3.65]	3.39[a,b] (0.89)	[3.33, 3.45]
Mixed-achievement grouping	3.72[c] (1.47)	[3.57, 3.88]	3.76[c] (1.33)	[3.65, 3.87]	3.46[a,b] (1.47)	[3.35, 3.56]
Measurement & advanced topics	2.73 (0.82)	[2.63, 2.82]	2.70 (0.83)	[2.62, 2.78]	2.64 (0.77)	[2.58, 2.70]
Average proficiency level	0.22[c] (0.20)	[0.20, 0.24]	0.20[c] (0.21)	[0.18, 0.22]	0.36[a,b] (0.23)	[0.35, 0.38]

Note. Standard deviations are in parentheses. Between-group differences significant at the 0.016 level (or lower) are specified as statistically significant for: (a) Black children, (b) Latino children, and (c) White children. All statistics were estimated using Stata *survey command*, including Early Childhood Longitudinal Study–Kindergarten Cohort weights.

Within the classroom learning environment, frequent exposure to traditional practices and computations instruction and average proficiency level of classmates were significantly associated with mathematics achievement of all children. Instruction in numbers and geometry was negatively associated with mathematics achievement for Black and White children. Instruction in measurement and advanced topics was associated with mathematics achievement only for Black children. Instruction in advanced numbers and operations was associated with mathematics achievement only for White children.

For all racial/ethnic groups, there was an association between entry-level mathematics skills and their achievement scores in the spring of kindergarten. Children who began kindergarten proficient in mathematics earned spring mathematics scores around 7 to 8 points higher than those who started kindergarten with limited mathematics skills.

Table 5 shows associations between home and classroom indicators and spring mathematics achievement for the two proficiency groups. Within the home, reading activities, access to learning tools, and parents' future expectations were associated with mathematics scores for both proficiency groups. For proficient children, general learning activities was also significantly associated with mathematics scores. For nonproficient children, involvement at school and parents' present educational expectations were also significantly associated with these scores. Within the classroom, both proficient and nonproficient children benefitted

TABLE 4. **Estimating Mathematics Achievement in the Spring of Kindergarten from Home and Classroom Learning Environments by Race/Ethnicity**

	Model 1: Black		Model 2: Latino		Model 3: White	
	M	*SE*	*M*	*SE*	*M*	*SE*
Proficiency in mathematics at kindergarten	6.76***	0.39	7.83***	0.38	7.68***	0.18
Home learning environment						
Reading learning activities	0.60**	0.24	0.43*	0.21	0.32*	0.14
General learning activities	−0.20	0.43	0.08	0.39	0.47*	0.24
Learning tools	0.65*	0.29	0.24	0.23	0.57***	0.13
Parents' involvement in school	0.93	0.59	0.94	0.63	0.56	0.42
Parents' future educational expectations	0.37**	0.12	0.19	0.11	0.21*	0.09
Parents' present educational expectations	0.91**	0.34	0.83**	0.31	0.21*	0.09
Classroom learning environment						
Amount of mathematics instruction	0.11	0.18	0.41	0.22	0.17	0.13
Numbers and geometry	−1.00***	0.28	−0.43	0.24	−0.44*	0.19
Advanced number and operations	0.01	0.13	−0.02	0.11	0.31***	0.08
Traditional practices and computation	0.59***	0.18	0.94***	0.16	0.86***	0.11
Student-centered mathematics instruction	−0.17	0.23	0.01	0.18	0.09	0.14
Mixed-achievement grouping	−0.03	0.11	−0.23	0.12	−0.02	0.07
Measurement and advanced topics	0.72**	0.24	0.35	0.24	−0.07	0.17
Average proficiency level	2.37**	0.86	1.71*	0.75	1.97***	0.50
R^2	0.50		0.55		0.49	
F-statistic	$F(31, 728) = 48.88$***		$F(31, 799) = 73.40$***		$F(31, 783) = 169.45$***	

Note. *P* values are based on estimations with robust standard errors. Coefficients for control variables are available from the authors.
*$p \le .05$. **$p \le .01$. ***$p \le .001$.

from receiving instruction in traditional practices and computation and advanced number and operations, and attending classes with a higher average proficiency level. There also was a negative association with numbers and geometry and mathematics scores. Children who started kindergarten with limited mathematics proficiency also benefited from additional overall instruction.

After controlling for home and classroom indicators plus additional covariates, the mathematics achievement difference between Latino and White proficient children was not statistically significant. This was not the case, however, for the achievement gap between Black and White children. White children who started kindergarten proficient in mathematics scored 2 points higher in the spring than their Black counterparts. For children with more limited initial mathematics proficiency, both the Black–White and Latino–White achievement gaps remained statistically significant. However, the Black–White gap was 50% larger than the Latino–White one.

Discussion

Research on educational inequality has consistently demonstrated the achievement disadvantages of racial/ethnic minority children (Cross et al., 2009). However, research has not examined whether the home and classroom learning environments have different associations with these children's mathematics achievement nor the extent to which mathematics achievement patterns of Black, Latino, and White children vary as function of their early mathematics skills. Documenting the relative importance of different aspects of the home and classroom learning environments is an important first step to devising programs to improve the mathematics skills of all children, especially those most at risk for difficulties.

Variability in Black, Latino, and White Children's Mathematics Achievement

There were three key differences in children's mathematics achievement. One, consistent with prior research, White children scored higher than Black or Latino children (Fryer & Levitt, 2004; Reardon & Galindo, 2009). More specifically, White children who started kindergarten with proficient mathematics skills received higher scores than their Black or Latino peers. Thus, even at the start of kindergarten, Black and Latino children were at a disadvantage relative to their White peers. Two, although the gap between children who started kindergarten with limited proficiency in mathematics and their White proficient peers decreased by the spring, there nevertheless remained a gap. Such a pattern also occurs with reading (Sonnenschein, Stapleton, & Benson, 2010) and highlights the importance of the skills with which children start school. Three, unlike the pattern for other children, the gap between Black and White children who began kindergarten with proficient mathematics skills increased by the spring of kindergarten.

TABLE 5. Estimating Mathematics Achievement in the Spring of Kindergarten from Home and Classroom Learning Environments by Initial Levels of Mathematic Skills

	Model 4: Proficient		Model 5: Nonproficient	
	M	*SE*	*M*	*SE*
Black	-2.05^{***}	0.37	-1.60^{***}	0.25
Latino	−0.49	0.32	-0.82^{**}	0.27
Home learning environment				
Reading learning activities	0.48^{*}	0.19	0.34^{**}	0.13
General learning activities	0.67^{*}	0.27	−0.06	0.23
Learning tools	0.82^{***}	0.17	0.27^{*}	0.13
Parents' involvement in school	0.20	0.53	1.12^{**}	0.36
Parents' future educational expectations	0.25^{*}	0.12	0.23^{***}	0.07
Parents' present educational expectations	0.28	0.21	0.80^{***}	0.17
Classroom learning environment				
Amount of mathematics instruction	0.16	0.16	0.30^{*}	0.12
Numbers and geometry	-0.49^{*}	0.22	-0.54^{***}	0.16
Advanced number and operations	0.23^{**}	0.09	0.18^{*}	0.07
Traditional practices and computation	0.76^{***}	0.13	0.83^{***}	0.10
Student-centered mathematics instruction	−0.01	0.16	0.06	0.13
Mixed-achievement grouping	−0.01	0.08	−0.08	0.07
Measurement and advanced topics	0.23	0.19	0.12	0.14
Average proficiency level	2.29^{***}	0.58	1.74^{***}	0.49
R^2	.19		.23	
F	$F(32, 802) = 29.17^{***}$		$F(32, 800) = 40.86^{***}$	

Note. *P* values are based on estimations with robust standard errors. Coefficients for control variables are available from the authors.
$^{*}p \leq .05$. $^{**}p \leq .01$. $^{***}p \leq .001$.

Variability in Home Learning Environments

A growing body of research shows the variability in home learning environments across racial/ethnic groups (Bradley et al., 2001; Brooks-Gunn & Markman, 2005). Consistent with such research, this study found significant variability in the home learning environments of Black, Latino, and White children. The magnitude of the majority of the differences were large enough (about 0.25 or larger) to be considered educationally meaningful (Wolf, 1986).

White children had greater access to reading and general learning activities and learning tools than Black or Latino children. Parents of White children also were more involved at their children's schools. The pattern of the home environment favoring White children was reversed for present and future educational expectations. Consistent with the findings of Suizzo and Stapleton (2007), Black and Latino parents reported higher educational expectations than White parents.

The variability observed in the home learning environments across racial/ethnic groups could reflect socioeconomic differences, cultural distinctions, and mismatches between the culture of the school and that of the parents. Latinos and Blacks are disproportionally represented among poor and low-income families (DeNavas-Walt, Proctor, & Smith, 2011). Only 8% of White children in this study lived in families below the poverty line, whereas 33% and 40% of Latino and Black children did. Such socioeconomic disparities can affect parental practices and educational opportunities (Kao & Thompson, 2003).

It is plausible that differences in the home learning environment also may reflect group-based differences in cultural understanding and meanings, given that parents provide their children with experiences that are culturally defined (Super & Harkness, 2002; Suizzo, Pahlke, Yarnell, Chen, & Romero, 2012). Cheadle and Amato (2011) suggested that Black and Latino families are less likely than White families to engage in concerted cultivation or deliberately foster children's cognitive skills. Differences in concerted cultivation would be consistent with differences across home learning environments. Differences in parents' present and future educational expectations are also consistent with cultural differences in parents' beliefs and goals. Suizzo et al. (2012) argued that racial/ethnic minority parents have higher educational expectations for their children because they perceive education as the means of improving their minority position within the social hierarchy of U.S. society, and increasing their future well-being.

Another possible explanation of the observed differences, particularly for parents' involvement at school, may be the cultural mismatch between racial/ethnic minority parents and schools (Galindo & Pucino, 2012). Black and Latino parents may feel less welcome at their children's schools and therefore less likely to be involved (Suizzo et al., 2012).

Although many of the findings from the home learning environments were maintained when the racial/ethnic groups were categorized into mathematics proficiency levels, there were two differences. One, children who started kindergarten with limited proficiency in mathematics obtained lower home learning environment scores than their proficient counterparts. This suggests that proficient children in each racial/ethnic group were coming from home environments with richer resources. Two, there was somewhat less racial/ethnic variability in the home learning environments of children with proficient mathematics skills than those with limited proficiency.

Variability in the Classroom Learning Environments

There was some variability in children's classroom learning environments. However, effect sizes for the classroom learning environment, except for classroom composition, were smaller than for the home learning environment. Differences between classroom environments for White children and Black children, again except for classroom composition, were larger than those between White children and Latino children.

White children attended classes with more children demonstrating proficient mathematics skills than Black or Latino children. Relatedly, perhaps, White children received less mathematics instruction and were exposed less frequently to certain pedagogical practices. The racial/ethnic differences in classroom composition were large and educationally meaningful; the differences in classroom pedagogical practices and amount of instruction were smaller.[1] Nevertheless, the differences in classroom practices between White and Black children (not White and Latino children) were educationally meaningful, with the exception of mixed achievement grouping and amount of instruction (Wolf, 1986). Such differences in the amount of specific types of instruction may reflect the differences in skills with which children started school. Given that White children started with higher mathematics scores, they may have needed less instruction in lower level mathematics skills and basic computations.

Many of the findings from the classroom learning environments were maintained when the racial/ethnic groups were further categorized into mathematics proficiency levels. A troubling pattern that emerged is that the nonproficient children were not necessarily exposed to stronger learning opportunities (either the overall amount or type of instruction), as we would have expected given their initial lower mathematics skills.

Findings for the classroom learning environment partially support other research showing qualitative and quantitative differences in the characteristics of schools that racial and ethnic minority children attend (Darling-Hammond, 2010). Schools that serve mainly minority children are likely to have a higher concentration of low income children, less qualified teachers, and limited course options (Clotfelter, Ladd, & Vigdor, 2005). The combination of low-quality teachers, limited school resources, and limited parental economic resources may partially explain why segregated schools perpetuate racial/ethnic educational disadvantages (Riegle-Crumb & Grodsky, 2010). White children in this study were more likely than Black or Latino children to attend mathematics classes with a higher percentage of proficient children.

Relation Between Home and Classroom Learning Environments and Children's Mathematics Achievement

This study shows the importance of the home and classroom learning environments for children's early mathematics development (Crosnoe, Leventhal, et al., 2010) and how the relative importance of certain indicators varies across different racial/ethnic groups and initial mathematics skill levels.

Home learning environments and children's mathematics skills. Engaging in reading activities at home was statistically associated with achievement for all three racial/ethnic groups and both initial mathematics proficiency levels. The association between reading activities at home and mathematics skills is an important contribution of this study. The importance of language skills for children's mathematics development is only beginning to be investigated (Hindman et al., 2010; Sonnenschein et al., 2013). Children need to understand the words used in mathematics problems and the language teachers use in instruction (Cross et al., 2009; Hindman et al., 2010). Engaging in reading in this study may have increased children's comprehension of words, which, in turn, would affect their mathematics skills.

Another contribution of this study is the focus on parents' present educational expectations for their children. Prior research typically has not examined what we are calling present expectations but has focused on future expectations. Present expectations, as assessed in this study, focused on skills parents expected their children to acquire within the year. Both present and future expectations were associated with children's mathematics skills, although the relation differed across racial/ethnic and proficiency groups. Present expectations were significantly associated with the mathematics skills of Black, Latino, and White children and those who started school with limited mathematics proficiency. Future expectations were associated with Black and White children's mathematics scores and those of children from both initial proficiency groups. The short- and longer term expectations that parents convey to their children may be associated with children's motivation for learning and, thus, their acquisition of academic knowledge (Pomerantz & Moorman, 2007; Sy, Gottfried, & Gottfried, 2013).

Although there were clear commonalities in home and mathematics associations across groups, there also was significant variability. That is, associations between the home and children's mathematics skills varied across groups. These findings highlight the need to consider the home learning environment in conjunction with demographic aspects of the child in order to decrease or eliminate present gaps in achievement. Access to learning tools was associated with Black and White children's mathematics scores but not Latino children's. Parent involvement in school was associated with mathematics scores of children who began school with limited mathematics skills but not those who started with higher mathematics competencies.

Classroom learning environments and children's mathematics skills. Instruction in traditional practices and computations was associated with Black, Latino, and White children's and both proficiency levels' spring mathematics scores. Such instruction may foster fluency in number sense and basic operations that serve as a necessary foundation for higher level mathematics.

Even though Black and Latino children received more instruction in traditional practices and computations than White children, it was not sufficient for them to close the achievement gaps. Black and Latino children may have needed a greater amount of instruction or instruction in areas not documented in this study to address limitations in their initial skills. As previously noted, the quality of the instruction and the school resources may further limit Black and Latino children's achievement.

Another important association with many of the children's mathematics scores was the percentage of children in the class with proficient mathematics skills. However, this factor may be less subject to modification within the classroom because it reflects societal stratification.

Importance of initial mathematics proficiency. An important contribution of this study is documenting the associations between mathematics proficiency at the start of kindergarten and children's mathematics development during kindergarten. Clearly, starting kindergarten with proficient mathematics skills is an advantage. Regardless of racial/ethnicity, children who started kindergarten proficient in mathematics earned scores 7 to 8 points higher in the spring than those who started with limited mathematics skills. Starting kindergarten proficient in mathematics, eliminated Latino–White mathematics gaps, after controlling for home and classroom and other covariates. However, Black–White gaps remained, illustrating differential patterns of association across racial/ethnic groups. Furthermore, the gaps between White and Latino (or Black) children were not eliminated if the children were not initially proficient in mathematics.

Although proficiency may be a key factor in subsequent mathematics skills (e.g., Duncan et al., 2007), these results show the importance of also considering the home and classroom learning environments.

Limitations and Future Research

Although this study increases our knowledge of factors promoting mathematics skills of Black, Latino, and White children who start kindergarten with different levels of mathematics proficiency, there, nevertheless, are some limitations to the study. One, the alphas for the home and classroom indices were sometimes fairly low, although consistent with other research (Crosnoe, Leventhal, et al., 2010). Two, the information from the parents and teachers were self-reports and may not be a veridical representation of actual practices. Three, we focused on three broad racial/ethnic groups and did not consider intragroup variability. Four, there were few questions in the dataset that focused on specific mathematics activities at home. It would be useful for future studies to include additional questions on the topic. Five, there were some significant differences (in SES, racial/ethnic diversity, instructional patterns) in the analytic and excluded sample that may limit the generalizability of the findings. However, as noted in a prior section, the excluded sample showed disadvantages in several of the key indicators analyzed, thus, the observed associations observed in this study may have been stronger if the excluded students had remained in the study.

Future researchers should address the limitations described previously. In addition, researchers should examine the nature of the Black–White mathematics achievement gap. Our findings showed that this gap did not close for children who started kindergarten proficient in mathematics skills or those who started with more limited mathematics skills when home and classroom indicators were included in the model. Research should investigate whether this finding reflects a trend over time; if so, it suggests classroom learning environments are not sufficiently supporting these children's mathematics learning. In addition, the nature of the measures may not have been sufficiently sensitive or tapped all relevant indicators. Relatedly, it is plausible that some dynamics, harder to understand through quantitative research, are not being included in the model. Thus, research on the Black–White achievement gap could benefit from taking a qualitative approach. Finally, future interventions will need to consider more carefully the proficiency levels children display at school entry, as well as the varied contexts in which children's learning occurs.

Conclusions

Mathematics is a cornerstone of the educational system and an area that is important for subsequent success. However, many children, particularly Black and Latino children, start school with limited mathematics skills. These results show the importance of children's home and classroom learning environments and their initial mathematics skills. There was significant variability in the home and classroom learning environments of Black, Latino, and White children who started school with different levels of mathematics proficiency. White children experienced home environments richer in resources. Nevertheless, each group of children had home learning indicators associated with mathematics achievement that could serve as the cornerstone of interventions to improve their mathematics skills.

Much of the resources of the classroom learning environment favored the Black and Latino children. However, the instruction was not always sufficient to close the gap between them and White children, especially if they entered school with limited mathematics skills. If we are to improve the achievement of Black and Latino children we need to invest greater and high quality resources into their classrooms and seek more effective means of developing these children's mathematics skills. One promising avenue may be focusing on what is occurring during the preschool years at home and school to foster higher mathematics skills when children enter kindergarten.

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The order of authors is random; both authors equally contributed.

NOTE

1. As Slavin (1990) argued, effect sizes based on Cohen's *d* of 0.25 and larger are educationally meaningful.

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