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Home Mathematics Environment and Math Performance of Chilean Students in Kindergarten and Grades 1 to 3

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Abstract

We investigated whether home math activities were related to children's math performance in kindergarten and the first three years of primary school. Participants were Chilean parents and their children in kindergarten, Grade 1, Grade 2, and Grade 3 (*n*s = 101, 95, 87, and 84, respectively). Mothers and fathers independently answered questions about their math activities at home, provided sociodemographic information, and completed an arithmetic fluency task. Children completed measures of applied problem solving, calculation, and arithmetic fluency. For kindergarten children, we found that mothers' (but not fathers') reports of the frequency of operational (e.g., mental arithmetic) activities were positively related to children's math performance, whereas mothers' reports of the frequency of mapping (e.g., counting, number naming) math activities were negatively correlated with performance. For children in Grades 1-3, home math activities were not significant unique predictors of math outcomes. The socioeconomic status of children's schools and maternal math fluency predicted children's math performance in Grades 1-3. The implications of these findings are discussed for understanding how children's home environments are related to their mathematical development.

Keywords: home mathematics environment, children, parents, math activities, socioeconomic status, early mathematics

Home Mathematics Environment and Math Performance of Chilean Students in Kindergarten and Grades 1 to 3

The home mathematics environment (HME) encompasses the activities, resources, and opportunities that parents provide to support their children's math learning (Hornburg et al., 2021). According to a recent meta-analysis (Daucourt et al., 2021) and a systematic review (Mutaf-Yıldız et al., 2020), the HME is correlated with children's current and longitudinal numeracy skills, although the size of the effect is small. Moreover, the association between the HME and math achievement is higher for children in preschool and kindergarten than for children in primary and secondary grades (Daucourt et al., 2021). However, less research has focused on home math activities beyond kindergarten (Daucourt et al., 2021), and few studies have considered parental and school factors such as school socioeconomic circumstances or parents' own math skills in children in primary school (Cheung et al., 2020), when studying the HME. Consequently, in the present research we explored the HME for Chilean children of low- and high-socioeconomic status in kindergarten and in the first years of primary school, and evaluated the relations among parental factors (i.e., math fluency and educational attainment), home math activities (i.e., formal mapping, formal operational, and informal), and children's math performance in kindergarten and Grades 1-3.

Home Math Environment

Experiences of Preschool and Kindergarten Children

Skwarchuk et al. (2014) proposed a Home Numeracy Model to explain how formal activities (i.e., those with an explicit teaching focus), and informal home math activities (i.e., those where math learning is incidental) were related to children's math performance in Canadian children aged 4 to 6 years. This model has been replicated and expanded in recent research with Chilean children, showing that reported math activities at home predicted children's math

performance and growth of math skills on several tasks (Susperreguy et al., 2020b). Although some researchers have not found associations between the home math environment and children's math performance (e.g., DeFlorio & Beliakoff, 2015; Missall et al., 2015), a recent meta-analysis reported an average correlation coefficient between the home math environment and children's math achievement of $r = .13$ (Daucourt et al., 2021).

Not all home activities are related to children's mathematical performance, however. In this research we distinguished between *mapping* and *operational* formal activities to further explore the nature of the activities in which parents engage at home with their children. Mapping activities are those focused on the different ways of representing numbers (e.g., verbal counting, matching digits and quantities), whereas operational activities refer to operating on numbers and quantities (e.g., doing mental arithmetic; Susperreguy et al., 2020b). The frequency of operational activities is positively correlated with children's mathematical performance on several tasks (del Río et al., 2017; Skwarchuk et al., 2014; Susperreguy et al., 2020b). In contrast, when parents have been asked about mapping activities, such as naming digits or quantities, the frequency of reports of these activities are either weakly related to children's performance (Soto-Calvo et al., 2020), or predictive of poorer numeracy skills in subsequent years (Silinskas et al., 2020; Susperreguy et al., 2020b).

Informal math activities include parent-child activities that might promote math skills, but that do not actively involve teaching or learning of math (e.g., playing board games, engaging in cooking, Ramani & Siegler, 2008; Vandermaas-Peeler et al., 2012). In addition to the frequency of informal math activities, other research has assessed parents' knowledge of number-related games as a proxy of their engagement in informal math with their children (Skwarchuk et al., 2014). More generally, research on the HME in kindergarten supports a model in which

operational activities and informal experiences are both related to children's mathematical skills prior to formal schooling (Dunst et al., 2017; Mutaf-Yıldız et al., 2020).

Experiences of Primary School Children

Less research has explored the home mathematics experiences of children in the first few years of primary school, compared to the number of studies with kindergarten and preschool children (Daucourt et al., 2021). In the available studies with primary school students, however, the findings have not been conclusive. For example, Zhu and Chiu (2019) found that math activities at home were related to children's math achievement in primary school, whereas Zhang et al. (2020) found a similar link only for math activities involving applications. In a recent meta-analysis, grade was a significant moderator of the association between the HME and children's math performance: The correlations were higher for children in kindergarten and preschool samples, compared to samples of children in primary or secondary grades (Daucourt et al., 2021). In summary, some evidence suggests that the home math activities that children experience in preschool and kindergarten continue to be related to their math performance one to three years later. Little evidence about the HME in those later years is available, however.

Information about the HME in the primary grades is critical because it may differ from the experiences of children in preschool and kindergarten (Silinskas et al., 2020). Parents typically decrease the cognitive stimulation they provide when children transition to primary school (Powell et al., 2012). As a consequence of children being in primary school and receiving more intensive instruction than in kindergarten, school variables could have a more important role than parental activities at this age. Alternatively, parents may engage in different math activities with their older children, ones that are aligned with school assignments (Jeynes, 2005), teachers' reports of children's performance or children's homework (i.e., responsive parenting; Silinskas et al., 2020). In summary, many questions remain about whether, in the first years of

primary school, parents continue doing formal and informal math activities with their children at home, and if those activities relate to children's math performance.

Parental Characteristics, Socioeconomic Status, and Children's Math Skills

Parents' Math Fluency

Parental factors other than the proximal home math activities that they provide may also be important for understanding how children's experiences shape their mathematical learning. Some studies reported a positive association between parents' own math performance and that of their children (Braham & Libertus, 2017; Navarro et al., 2018), whereas no associations were found in other studies (Silver et al., 2020). Parental math performance could be linked to the activities parents engage in at home with their children, but such links have rarely been assessed (but see Silver et al., 2020). Thus, more research is needed to better understand how parents' own math performance is linked to the home math activities parents engage in at home.

Socioeconomic Status

Socioeconomic status (SES) is correlated with children's mathematical learning (Jordan & Levine, 2009; but see Mutaf-Yıldız et al., 2020). In a meta-analysis, Sirin (2005) found a positive, moderate correlation between students' math performance and SES, reporting that grade moderated the correlation between achievement and SES, with increasing effect sizes from kindergarten to middle school. Davis-Kean et al. (2020) proposed a model in which SES is related to children's achievement via parental beliefs and the cognitive stimulation parents provide to their children. According to this view (see also Elliott & Bachman, 2018), home math activities could mediate the associations between SES and children's math performance, though the evidence is inconclusive (Mutaf-Yıldız et al., 2020).

Socioeconomic status, however, can be conceptualized and measured in various ways, such as parents' educational attainment, family income, parents' occupation (Davis-Kean et al.,

2020), or school SES (del Río et al., 2017). Although different measures of SES may be correlated (e.g., parent educational attainment and school vulnerability), the ways in which these SES measures are related to the HME and children's math performance could vary across countries.

In Chile, for example, mothers' education was related to the home math activities they reported (Susperreguy et al., 2020b), but in Belgium, no such links were found (De Keyser et al., 2020). Notably, children in Belgium experience uniformly high-quality preschool, whereas in Chile, the quality of preschool (Herrera et al., 2005) and school (Ramírez, 2006) experiences vary by the socioeconomic conditions of the educational institutions themselves. Indeed, schools in Chile are highly segregated in terms of the SES of the students (Valenzuela et al., 2014), and individual-level data from standardized tests (both national and international) show that students' SES is associated with Chilean students' educational outcomes (Agencia de Calidad de la Educación, 2015a; Ramírez, 2006).

There are three types of schools in Chile: fully private, private-voucher, and public schools. For private-voucher and public schools, the Chilean government provides a per-student subsidy, which comes directly from the national budget of the Ministry of Education. In contrast, private schools do not receive any subsidies from the government and thus they serve a small group of high-income families (Mizala & Torche, 2012). For example, in 2018 (year the data for this study were collected), only 9% of the Chilean kindergarten and primary school enrollment corresponded to students in private schools, 38% to students attending public schools, and 53% to students in private-voucher schools (Centro de Estudios Mineduc, 2021). In accord with these school disparities in SES, students in private schools have higher achievement than those in public or private-voucher schools (Agencia de Calidad de la Educación, 2015a). Thus, the associations between the HME, specific aspects of family socioeconomic status, and children's

math performance need to be further explored, especially in countries that have substantial SES disparities, such as Chile.

The Contributions of Fathers and Mothers to the Home Math Environment

Most of the prior research on HME has concentrated on the ways in which mothers engage in math with their children at home (Mutaf-Yıldız et al., 2020). In a few studies, researchers have found differences in the relations between maternal and paternal activities and children's math outcomes (del Río et al., 2017; Huang et al., 2017; Liu et al., 2019). For formal activities, mothers of 5-year-old Hong Kong Chinese children reported a higher frequency of home math activities with their children than did fathers (Huang et al., 2017), and mothers', but not fathers', engagement in formal math activities was linked to math performance in children from Chile (del Río et al., 2017) and Hong Kong (Huang et al., 2017). For informal activities however, Liu et al. (2019) found that fathers of 3-year-old Hong Kong Chinese children reported a higher frequency compared to mothers. Moreover, Huang et al. (2017) found that informal activities involving games and applications reported by fathers of 5-year-old children, but not mothers, were related to Hong Kong Chinese children's math performance. Thus, the small amount of available research suggests that mothers and fathers report different frequencies of formal and informal math activities and the relations between these reported activities and children's performance sometimes vary across parents.

Current Research

In the current study, we explored the relations among school SES, parents' education, parents' math fluency, and math performance for Chilean children in kindergarten and the early years of primary school. Participants were recruited from schools that, on average, enroll children from either low- or high-SES families. In general, Chilean children underperform on international standardized tests, compared to other OECD countries (Organisation for Economic Co-operation

and Development (OECD), 2019). Moreover, Chile has large SES disparities in children's performance on international math assessments (OECD, 2019) and on national standardized tests (Agencia de Calidad de la Educación, 2015a; Mizala & Torche, 2012). Thus, SES is an important factor in children's educational experiences in Chile. We hypothesized that children in low-SES schools would have lower math performance than children in high-SES schools.

Research Question 1: What are the Similarities and Differences in the Home Math Environment Provided by Mothers and Fathers of Kindergarten and Grade 1-3 Children?

We assessed home math activities of kindergarten children with a questionnaire that has been widely used in prior research (i.e., del Río et al., 2017; Skwarchuk et al., 2014; Susperreguy et al., 2020a; Susperreguy et al., 2020b). To extend the HME assessment to children in Grades 1-3, we adapted questions and developed new ones that targeted experiences suitable for older students. We expected that both parents would engage in home math activities with their children in kindergarten and in Grades 1-3.

We also compared the home math activities reported by mothers and fathers. We hypothesized that mothers would report a higher frequency of formal home math activities than fathers in kindergarten and in Grades 1-3. This hypothesis is based on earlier work with kindergarten children (del Río et al., 2017; Huang et al., 2017). We also note that Chilean mothers spend more time overall with their children (Instituto Nacional de Estadísticas, 2015) and thus have more opportunities for engagement.

Research Question 2: How are Parental Factors (i.e., Math Fluency and Educational Attainment) and School Socioeconomic Status Related to Home Math Environment and Children's Math Performance in Kindergarten and Grades 1-3?

We hypothesized that parents' math fluency (Cheung et al., 2020) and educational attainment (Cheung et al., 2020; Susperreguy et al., 2020b) both would be positively related to

children's math performance. Moreover, we hypothesized that more educated parents would engage in more operational activities with their children and report more number-related games than parents with lower educational attainment (Susperreguy et al., 2020b). Given the segregation of the Chilean educational system (Valenzuela et al., 2014), and the association between school SES and student outcomes (Mizala & Torche, 2012), we also hypothesized that the mathematical performance of children would be related to their school SES.

Research Question 3: Does the Home Math Environment Predict Math Performance for Children in Kindergarten and in Grades 1-3?

We hypothesized that, in kindergarten, operational and informal activities would be positively related to children's math performance (Skwarchuk et al., 2014; Susperreguy et al., 2020b) whereas mapping activities would be negatively related to children's math performance (Susperreguy et al., 2020b). For children in Grade 1-3, we also hypothesized that parents' reported home math activities would be related to children's achievement, based on the extensive literature linking parent involvement with children's school performance (Jeynes, 2005). However, we speculated that when children transition to primary school, schooling would become a dominant factor in children's math development and thus that the associations between home math activities and children's math performance in primary school would be smaller than those found in kindergarten.

Method

Participants and Procedure

This study is a part of a larger project investigating home mathematical experiences and children's development of math skills from kindergarten through the first years of primary school. The study received ethics approval by the Institutional Ethics Review Committee at (blinded). Principals of six schools (three high-SES and three low-SES schools) in the urban

metropolitan area of Santiago, Chile, were contacted. The schools were selected based on prior research participation and other collaborations. All the principals agreed to participate, but as one of the schools was already actively engaged in another research project, it was not included. Therefore, two high-SES and three low-SES schools participated in the study. Once principals agreed to join the study, parents were invited to participate with their children. Most of the schools' teachers sent letters home with the children. The study required both parents to participate; therefore, once both parents agreed to participate, they received a phone call to explain further details of the project and to schedule a home visit, where parents signed consent forms and completed questionnaires. The participation rate of the parents approached 30%.

At the home visit, both parents completed a home environment questionnaire and other assessments of their math-related beliefs (Authors, date). Children were tested in a private room at their schools in two sessions of approximately 20-30 minutes each, after granting verbal assent. All tasks were presented to children in the same order. Children were tested in the second semester of the 2018 school year, during a four-month period, after parents completed the questionnaires. Two primary caregivers of each child, one female and one male, completed the parent questionnaire. Almost all the female primary caregivers were mothers (97.8%), and most of the male primary caregivers (85.6%) identified as fathers of the children. The other primary caregivers identified as grandparents, aunts, uncles, or other household figures, though two male figures did not provide this information. The analyses included one female and one male primary caregiver per child, who will be referred to as mothers and fathers, respectively.

Children (all Spanish speaking) were in kindergarten (n = 101), Grade 1 (n = 95), Grade 2 (n = 87), or Grade 3 (n = 84). Each parents' education was assessed on a 12-point scale, ranging from "some primary school" (1) to "doctorate degree" (12). The median level of maternal education was "some university" (9) for mothers of children in kindergarten and Grade 1, and

"some community college/professional institute" (7) for mothers of children in Grades 2 and 3. For paternal education, the median level was "graduated from university" (10) for fathers of children in kindergarten, "some university" (9) for fathers of children in Grade 1, "some community college/professional institute" (7) for fathers of children in Grade 2, and "graduated from technical, trade, or vocational training" (6) for fathers of children in Grade 3.

In the current study, two private schools participated. Both were considered high-SES schools for this study, per the classification by the Quality of Education Evaluation System (SIMCE in Spanish). Three publicly funded low-SES schools participated in the study. Publicly funded schools are subsidized by the Chilean government due to the vulnerability of their students. The Chilean National Council for School Assistance and Scholarships (JUNAEB) computes an annual vulnerability index for schools (Índice de Vulnerabilidad Escolar, IVE, Agencia de Calidad de la Educación, 2015b). The information used to compute this index comes from a survey of vulnerability administered to families, and from information from the financial entity entrusted to collect, manage, and distribute state funds for health (FONASA), the national Minors' Service (SENAME), and the Civil Registry System (Registro Civil), as well as grades, school achievement, and attendance records from prior years (Agencia de Calidad de la Educación, 2015b). Students are classified into three categories (called "priorities") according to their poverty level and their likelihood of school failure or dropout. First priority students are those experiencing severe poverty whereas second and third priorities denote students with a likelihood of school failure. The IVE totals the number of students in each of the three priority levels and divides that by the total number of students enrolled in the school. The results are multiplied by a hundred to ease interpretation. The IVE ranges from 0 to 100%, where higher percentages represent a higher degree of vulnerability in the school. The three low-SES schools participating in this study had IVEs ranging from 74% to 85% in 2018. Despite some differences,

the three schools were similar in the percentage of priority students they serve and, thus, all were classified as low-SES schools for this study.

In the current sample, approximately half of the children in each grade attended low- versus high-SES schools (50 vs. 51 in kindergarten; 46 vs. 49 in Grade 1; 52 vs. 35 in Grade 2; and 52 vs. 32 in Grade 3), $\chi^2(3, N = 367) = 5.26$, $p = .15$. Similarly, there were approximately equal numbers of boys and girls in each grade (48 vs. 53 in kindergarten; 52 vs. 43 in Grade 1; 47 vs. 40 in Grade 2; and 38 vs. 46 in Grade 3), $\chi^2(3, N = 367) = 2.40$, $p = .49$. The mean ages of the children in the sample in months (*SD*s) for kindergarten, Grade 1, Grade 2, and Grade 3 were 71 (4.4), 82 (4.8), 95 (5.2), and 106 (5.0), respectively.

In the present study, we consider parental education and school SES separately because the former is a home environment factor whereas the latter is a school environment factor. Despite high correlations between the two variables (ranging from .55 in Grade 1 to .73 in Grade 3 for maternal education and SES, and .59 in Grade 1 to .70 in Grade 2 for paternal education and SES), 20.6% of children who had highly educated mothers (i.e., mothers with a university degree) and 13.8% of children who had highly educated fathers attended low-SES schools. Similarly, 20.9% of children who had less-educated mothers (i.e., mothers without a university degree) and 26.9% of children who had less-educated fathers attended high-SES schools. Thus, home and school SES are not entirely redundant.

Materials

Parent Factors

Parents, both mothers and fathers, were asked to complete a home environment questionnaire that included demographic questions. Home math activities are listed in Table 1. The kindergarten version of the questionnaire has been used in prior research (del Río et al.,

2017; Susperreguy et al., 2020b), and it is based on the questionnaire developed by Skwarchuk et al. (2014). The questionnaire for parents of children in Grade 1 included some of the same questions used for the kindergarten parents, but it also included other questions designed to tap into developmentally appropriate activities. Parents of children in Grades 2 and 3 answered some of the questions used for kindergarten and Grade 1 children, plus others referring to more challenging skills (Table 1).

Home Mathematics Activities. For the formal math activities, parents reported their frequency of engagement on a scale ranging from rarely or never (1) to the majority of the days in a week (5). The list of formal math activities that parents reported at each grade is included in Table 1. Based on theoretical definitions and prior work in the area (Susperreguy et al., 2020b), the items were classified as either operational activities or mapping activities. Operational activities included manipulations of numbers or quantities and performing math operations, whereas mapping activities included identifying and representing numbers, weighing/measuring, and other activities that focused on determining quantities. Two items (i.e., about multiplication and fractions) were not asked to the Grade 1 parents and were excluded from the composite scales. Reliability coefficients for the mapping and operational scales are presented in Table 1. Mean scores for mapping and operational scales for mothers and fathers were used in analyses.

For parents in all grades, exposure to informal math activities was assessed using a number-game checklist adapted from Skwarchuk et al. (2014) and used with Chilean parents in prior research (Susperreguy et al., 2020b). In this task, parents see a list of 25 games, 10 of which have numerical content, 10 of which are real games but not primarily numerical, and 5 of which are foils (i.e., plausible games). Parents are instructed to select the games they know. Scores were scaled and adjusted for guessing, thus, the informal score = ([# of correct number games selected – # of foil games selected]/10), with possible scores ranging from 0 to 1. The scores were

standardized separately for the kindergarten children, and the Grades 1-3 children. This measure is used as a proxy for parents' participation in informal math activities with their children.

Math Performance. Both parents completed the Math Fluency subtest of the Batería III Woodcock-Muñoz Pruebas de Aprovechamiento (WJ III Tests of Achievement, Muñoz-Sandoval et al., 2005). In this task participants are given three minutes to solve simple arithmetic problems, including single-digit addition, subtraction, and multiplication. The score is the number of correct items solved in that time. Cronbach's α, based on the items where 75% of parents responded (n = 75 items), was .67 for mothers and .89 for fathers.

Children's Measures

As part of the larger project, children completed several math and cognitive tasks. For the current analyses, only the instruments that were administered to children in all grades to assess mathematical performance are included. These consist of three mathematics subtests of the Batería III Woodcock-Muñoz Pruebas de Aprovechamiento (WJ III Tests of Achievement, Muñoz-Sandoval et al., 2005): Calculation, Applied Problems, and Math Fluency.

Calculation. In this subtest, children are asked to write the answer to mathematical calculations that are presented on a sheet of paper. The calculations are organized by increasing level of difficulty, and the starting point depends on the grade of the child (Mather & Woodcock, 2005). The first eight items are single-digit addition and subtraction. The subsequent six items are increasingly complex, including addition or subtraction of two- and then three-digit numbers. Later questions include multiplication and division, plus other addition and subtraction items of increasing difficulty. Following these items, calculations required involve fractions, money, and basic equations. The score is the total number of correct responses. The testing is terminated once a student has six consecutive errors or fails to respond. Consequently, reliability for the Calculation subtest in the current sample was computed based on the items where 75% of

children attempted to respond. Cronbach's α = .78 (kindergarten), .70 (Grade 1), .55 (Grade 2), and .69 (Grade 3). The lower reliability for older children is presumably related to the increased diversity of questions (i.e., beyond whole number calculations).

Math Fluency. Children are given three minutes to complete simple arithmetic calculations in this subtest, which include single-digit addition, subtraction, and multiplication. The score is the total of correct calculations solved within three minutes. Cronbach's α, based on the items where 75% of children responded, were .77 (Grade 1), .79 (Grade 2), and .81 (Grade 3).

Applied Problems. In this subtest children solve math calculation problems that are presented verbally and accompanied by a visual stimulus (usually a picture). Problems become more complex and may include text in addition to numbers or pictures. The starting point depends on the grade of child (Mather & Woodcock, 2005). The task is discontinued after six consecutive errors or failures to respond, and the score is the total number of correct responses. Consequently, we computed Cronbach's α based on the items where 75% of children attempted to respond. The Cronbach's α were .66 (kindergarten), .69 (Grade 1), .64 (Grade 2), and .71 (Grade 3). The moderate reliability probably reflects the diversity of the items on the test.

Results

Data Reduction

Principal component analyses (PCA) were conducted to create a single math outcome variable for each group. For kindergarten children, the Math Fluency subtest was not included in the PCA because 75% of the children attempted only one item. One factor was specified in each analysis. For kindergarten children, the factor loadings of the math subtests were 0.899 (Calculations) and 0.899 (Applied Problems), explaining 80.84% of the variance. For children in Grades 1-3, the factor loadings were 0.911 (Calculations), 0.917 (Applied Problems), and 0.916

(Math Fluency), explaining 83.67% of the variance. The factor scores were saved to use in subsequent analyses.

Research Question 1: What are similarities and differences in the Home Math Environment Provided by Mothers and Fathers of Kindergarten and Grade 1-3 Children?

Table 1 includes the mean frequencies with which each parent reported they engaged in home math activities with their children. Some of the activities were queried at all grades (e.g., encouraging the child to do math in his/her head), whereas other activities targeted specific grades to capture the range of activities parents might engage in with their children as they grow. In general, among the items that were included for all grades, parents reported very similar frequencies, regardless of the grade of the children. The stable patterns of frequencies across grades suggest that these questions were interpretable by parents, but we also assume that parents report their activities in relation to their children's skills at each grade.

On average, mothers of kindergarten children reported a significantly higher frequency than fathers for most of the operational (i.e., helping learn simple sums; talking about time with clocks and calendars; and playing games or doing activities involving counting, adding or subtracting) and mapping activities (i.e., asking about quantities; helping the child to recite numbers in order; singing counting songs; and encouraging the use of fingers to indicate how many; see Table 1). In Grades 1-3, mothers reported a significantly higher frequency of home math activities than fathers on four items: two operational activities (i.e., encouraging the child to practice number facts in Grades 1-2; practicing counting, adding and subtracting in daily life in Grades 2-3); one mapping activity (i.e., practicing answering how many without counting in Grade 1); and teaching multiplication tables in Grade 3. In brief, fathers never reported engaging in more home math activities than mothers in either kindergarten or Grades 1-3.

In terms of informal math, which was measured by parents' knowledge of number-related games, there were no differences between mothers and fathers of kindergarten children. However, mothers of children in Grades 1-3 recognized a higher percentage of number-related games than fathers, $t(529) = 4.12$, $p < .001$, $d = .36$.

Home Math Environment and School SES

Analyses comparing parents' reports of home math activities by school SES were conducted. For kindergarten, there were no significant differences in reports of mapping or operational activities by school SES for either parent. Similarly, in Grades 1-3, reports of operational activities did not differ by school SES for mothers or fathers. However, parents of children enrolled in low-SES schools reported engaging in mapping activities more frequently than those of children in high-SES schools. This difference was significant both for mothers (Ms = 3.04 vs. 2.48), $t(264) = 4.99$, $p < .001$, $d = .62$, and for fathers (Ms = 2.73 vs. 2.33), $t(264) = 3.327$, $p < .001$, $d = .41$. For informal activities (i.e., number game knowledge), fathers of kindergarten children and mothers of children in Grades 1-3 in high-SES schools had higher scores than those in low-SES schools (see correlations in Tables 2 and 3). In contrast, mothers of kindergarten children in high-SES schools had lower scores than mothers of children in low-SES schools (see Table 2).

Research Question 2: How are Parental Factors (i.e., Math Fluency and Educational Attainment) and School Socioeconomic Status Related to Home Math Environment and Children's Math Performance in Kindergarten and Grades 1-3?

Descriptive statistics and correlations for all measures are included in Table 2 (kindergarten) and Table 3 (Grades 1-3). As expected, given the segregation by SES in the Chilean educational system (Valenzuela et al., 2014), in kindergarten (Table 2) and in Grades 1-3 (Table 3), mother's education, father's education, and school SES were highly correlated; the

parents of children who attended high-SES schools were more educated, on average, than the parents of children who attended low-SES schools. Moreover, school SES was significantly correlated with children's math outcomes in kindergarten and Grades 1-3: Children who attended high-SES schools had higher math scores than children who attended low-SES schools.

There were no significant correlations between gender and math performance in kindergarten or Grades 1-3. Gender was not related to mothers' reports of mapping or informal activities for kindergarten children, but mothers of children in Grades 1-3 report engaging in more operational activities with boys than with girls, $t(264) = 2.51$, $p = .01$, $d = .31$. There were no gender differences in the frequencies of activities that fathers reported.

Some correlations among parental factors were found for both parents. Parents' fluency was positively related to their educational level, in that parents with higher education performed better on the math tests than parents with lower educational attainment. Other correlations varied by the parent. Mothers' math fluency was correlated with children's math performance in kindergarten and in Grades 1-3, whereas fathers' math fluency was correlated with children's math performance in Grades 1-3 but not in kindergarten.

Among the home math activities, the frequencies of both types of formal home math activities (i.e., mapping and operational activities) reported by mothers and fathers were highly correlated in both groups of children. Parents' education and parents' math fluency were all negatively correlated with their reports of the frequency of mapping activities in Grades 1-3. Thus, parents of children in Grades 1-3 who had higher education or higher math fluency scores reported less frequent mapping activities at home.

Other correlations varied across parents. For mothers of kindergarten children, recognition of number-related games was not correlated with children's math performance or reports of home activities, whereas for fathers, there were significant correlations between

number-game recognition and both mapping activities and children's math performance. Mothers' education was correlated with informal math for children in kindergarten, whereas fathers' education was correlated with informal math for children in kindergarten and Grades 1-3. Operational activities reported by fathers were correlated with their educational attainment for children in Grades 1-3 and with their children's math performance. However, parents' recognition of number games for children in Grades 1-3 was not correlated with children's math performance. In summary, parents' education, school SES, and parents' math fluency showed consistent correlations with children's math performance across grades, whereas the relations between the HME and other factors were more variable.

Research Question 3: Does the Home Math Environment Predict Math Performance for Children in Kindergarten and in Grades 1-3?

Multiple regression analyses were conducted to determine whether home math activities predicted children's math performance in kindergarten and in Grades 1-3. In Model 1, the predictors were child's grade in school, grade by school SES interaction (for the analyses of children in Grades 1-3), school SES, and children's gender. In Model 2, predictors were parents' education and parents' math performance. In Model 3, home math activities (i.e., informal, mapping, and operational) were added to the analyses. Separate analyses were conducted with maternal and paternal variables, and for children in kindergarten and in Grades 1-3 (see Table 4).

Model 1: Grade and School SES

As shown in Table 4, for Model 1, school SES predicted significant variance in math performance for kindergarten children. For children in Grades 1-3, grade in school and school SES predicted math performance. Moreover, the grade by school SES interaction was significant, indicating that the differences between students in high- versus low-SES schools increased with grade (see Figure 1).

Models 2 and 3: Maternal Variables

In Model 2, maternal math fluency predicted unique variance for children's math in Grades 1-3. Although the effect size for math fluency was very similar in kindergarten, presumably it was not significant because of the smaller sample size. The main effect of school SES was not significant in Model 2, presumably because there was substantial overlap between maternal education and school SES.

In Model 3, when the HME variables were added, mothers' reported mapping activities were negatively related to children's math performance in kindergarten, whereas operational activities were positively related to math performance. In contrast, mothers' reports of home math activities were not significant predictors of math performance for children in Grades 1-3. In summary, as hypothesized, the pattern of results for kindergarten children was consistent with existing research in which home math activities predicted performance. In contrast, no relations between the HME and math performance were found for older children.

Model 2 and 3: Paternal Variables

The fathers' HME variables did not explain variability in children's math outcomes in kindergarten or in Grades 1 to 3 (see Table 4).

Discussion

In this study, we examined the relations among children's math performance, the HME, school SES, and parental factors (i.e., education and fluency) for Chilean children in kindergarten and Grades 1-3. The results extend prior research on the HME of preschool children in relation to their numeracy skills in several ways (Mutaf-Yıldız et al., 2020). First, this research adds to the studies that have considered the HME of children in the years after kindergarten (Daucourt et al., 2021). Second, we explored the HME for both mothers and fathers. Third, we assessed the associations between the HME and children's math performance while also considering parents'

own math performance and educational attainment. The inclusion of both mothers and fathers and parental factors (i.e., math fluency and education), as well as school SES, allows for a comprehensive exploration of the associations between the HME and children's math performance in kindergarten and in early primary school. Finally, the results extend the research on the HME beyond North American and European samples.

Our results for kindergarten children were similar to those of previous research with samples from Chile (del Río et al., 2017; Susperreguy et al., 2020b), European, and North American countries (Mutaf-Yıldız et al., 2020): The home mathematics environment, as reported by mothers, was related to children's math outcomes after controlling for SES, mothers' education and math fluency, and children's gender. In contrast, for children in Grades 1-3, the home math activities reported by either parent were not associated with children's performance. Instead, school SES and mothers' math fluency were related to children's math skills in the primary school years. These findings provide some insight into the differing relations between children's math skills, the HME, and other parental and contextual factors, in children who are in kindergarten versus early primary school (Daucourt et al., 2021).

Research Question 1: Home Math Environment

Kindergarten versus Grades 1 to 3

We found that parents reported engaging in both mapping and operational formal math activities in kindergarten and in the first three years of primary school. The reported frequency of these two types of formal math activities were positively correlated, for both groups of children and for both mothers and fathers. These patterns suggest that those parents who engage in math experiences at home involve their children in a range of activities. Formal math activities were correlated with fathers' but not mothers' informal math activities, but only for children in kindergarten. Note that we assessed informal math activities using an indirect measure (i.e.,

recognition of games) and formal activities using direct parental reports of activities. Future research that includes parents' reports of both formal and informal activities could provide insights on the specific associations among these aspects of the home math environment.

Mothers and Fathers

Consistent with prior research (del Río et al., 2017; Huang et al., 2017), we found that for kindergarten children, mothers report more formal math activities than fathers. Mothers of Chilean children spend more time with their children than fathers (Instituto Nacional de Estadísticas, 2015), thereby allowing mothers additional opportunities to prompt formal math activities with their kindergarten children. In contrast, although there were a few formal activities for which mothers of children in Grades 1-3 reported a higher frequency than fathers, for most items there were no differences between mothers and fathers. For informal activities, fathers recognized fewer number games than mothers in Grades 1-3. Although one prior study found that fathers reported engaging in more informal number-game activities with younger children (Liu et al., 2019), we did not find differences between mothers and fathers in their informal math index in kindergarten. Overall, the main finding from our research is that mothers reported more frequent formal activities than fathers, with larger and more consistent differences across activities for kindergarten than for primary school children. Our assessments of the home math activities, however, were self-reports and might not capture other activities in which fathers and children engage in math at home.

Research Question 2: Parental Factors and Home Math Activities

We expected that parents' education (Susperreguy et al., 2020b) and math fluency (Cheung et al., 2020) would be related to their reports of home math activities. For kindergarten children, reports of formal math activities were not related to parents' education or math fluency. For Grade 1-3 children, there were negative correlations between mapping activities and parents'

education and math fluency. Thus, parents who are less educated and/or less skilled at math themselves reported more activities focused on number representations, counting, and measurement, than parents who are more educated or more skilled at math. These differences could reflect parents' sensitivity to their children's math skills (Silinskas et al., 2020). They may also reflect differences for high- and low-SES parents in their views of what kinds of home activities are relevant (Susperreguy et al., 2021). Future research is needed to unpack the negative associations between mapping activities and parental education and math fluency.

As hypothesized, maternal math fluency and education were correlated with children's math outcomes in both groups of children. Fathers' education was also correlated with children's math performance in kindergarten and in Grades 1-3, whereas father's math fluency was correlated with children's math performance in Grades 1-3. These findings are consistent with research indicating that parents' educational attainment serves as a foundation for children's achievement, albeit indirectly, through the home learning environment (Davis-Kean et al., 2020). In the present research, however, school SES and mothers' math fluency had higher correlations with children's math performance in Grades 1-3 than did education and were also each highly correlated with mothers' education. Thus, although maternal education was not a unique predictor of children's math performance, it is closely linked to school SES and maternal fluency. These interconnected factors may all reflect an underlying construct (e.g., social capital).

Research Question 3: Home Math Environment and Math Performance of Children in Kindergarten and Grades 1-3

Consistent with prior research (del Río et al., 2017), none of the HME factors specific to fathers predicted children's mathematics performance in either kindergarten or Grades 1 to 3, once SES was taken into account. In contrast, our findings with kindergarten children replicate some of the links between home math activities reported by mothers and children's outcomes

found in earlier research (Skwarchuk et al., 2014; Susperreguy et al., 2020a). Mothers' reports of operational activities predicted children's math performance, after controlling for children's gender, maternal education, maternal math fluency, and school SES. In contrast, mothers' reports of mapping activities were negatively related to math performance in kindergarten. Similar negative correlations have been observed in some prior studies with basic activities in Chile (Susperreguy et al., 2020b) and in Lithuania (Silinskas et al., 2020). In contrast to other research with Chilean (Susperreguy et al., 2020b) and Canadian children (Skwarchuk et al., 2014), informal activities, measured using mothers' recognition of number games, did not predict kindergarten math performance. Future studies need to include other types of assessments of informal experiences with children to better understand these mixed findings.

Contrary to the results for kindergarten children, mothers' reports of home math activities did not predict the math performance of older children. We expected to find associations between home math activities and children's math in Grades 1-3 (Daucourt et al., 2021). Instead, children's math performance was only related to mothers' math fluency and school SES. These factors presumably could also influence children's HME, but the home math activities of parents in this study did not directly predict unique variance in children's math in early primary school. Other aspects of the HME of children in Grades 1-3 not assessed in the current study might be relevant for students' performance at this age.

Maternal Fluency and Children's Math Performance

Our results suggest that parents' experiences and familiarity with math, as indexed by their math fluency, may be important to consider when trying to understand math performance of children in kindergarten and in the first three years of school. As in prior research (Braham & Libertus, 2017), we found that maternal math fluency was related to children's math performance. We found similar relations for children's math performance in both kindergarten

and Grades 1-3, although the relation was not significant in the kindergarten regressions, probably because of the smaller sample size. Notably, maternal fluency was highly correlated with education and school SES. In general, children of parents who had lower educational attainment attended lower-SES schools, compared to children of more highly-educated parents. Moreover, higher-educated parents had better math performance than lower-educated parents, consistent with research with parents in the Philippines (Cheung et al., 2020). Our findings highlight the possibility that maternal fluency, education, and SES may index similar factors in our research. Thus, SES disparities in math attainment of children in Chile cannot be separated from the educational experiences of their parents, their parent's math fluency, and their socioeconomic background. Consequently, the mechanisms by which maternal math performance is related to the home math environment and to math outcomes in children should be studied further (Borriello et al., 2020).

Socioeconomic Status and Children's Mathematical Performance in Chile

Consistent with the OECD findings for Chile as a whole (Organisation for Economic Co-operation and Development (OECD), 2019; Ramírez, 2006), children's math achievement in the present study was correlated with the SES of schools and the educational attainment of parents. We expected that proximal home factors, such as parents' fluency and their home math activities, would also explain part of the variance in children's math performance after taking into account school SES (Elliott & Bachman, 2018). We found support for this hypothesis for the kindergarten children: School SES was correlated with math performance but was not a significant unique predictor when mothers' math fluency and education were included in the regression. The HME variables also were predictors of children's performance in kindergarten.

Similarly, for older children, mother's math fluency and educational attainment were related to children's math performance, after accounting for school SES. Regardless, the math

achievement gap between low- and high-SES students was higher for older students, compared to younger students in primary school. Notably, this study targets distinct groups of high- and low-SES schools rather than sampling across SES (cf. Authors et al., date). In most studies of the home math environment, SES is measured at the family level and as a continuous variable, with most families being middle class. Often, SES is not related to children's outcomes when home factors are considered (Mutaf-Yıldız et al., 2020). Thus, more broad assessments of SES need to be included in future work. The close relations among school SES, parents' education, and parents' fluency, and their similar correlations with children's math performance, may also reflect the stratified society in Chile and thus may not generalize to other countries.

One factor, endemic to Chile, that could explain why school SES and math learning were related in the current research is that children in low- versus high-SES schools may experience disparities in mathematical instruction (Ramírez, 2006). In particular, teacher qualifications differ substantially between Chilean low- versus high-SES schools (Cabezas et al., 2017). Differences in teacher qualifications may lead to disparities in the quality of instruction and in the coverage of the academic content. In the last decade, the national mathematical assessment administered to all Chilean children has shown the same pattern as the data in the present research. Students from low-SES and middle-SES schools perform worse than students from high-SES schools (Agencia de Calidad de la Educación, 2015a). Thus, in the Chilean context, school segregation by SES might be exacerbating math achievement differences: Low-SES children do not have equal opportunities to learn inside or outside of school (Mizala & Torche, 2012).

The question of why the home math environment was related to children's math performance in kindergarten but not in Grades 1-3 in this Chilean sample (after accounting for school SES), requires further investigation. It could be that the SES disparities in math instruction have a more pervasive role in primary school, where more formal hours are allocated to math

instruction in the Chilean curricula. It could also be that parents' support for math at home takes a different approach, one more aligned with school requirements (e.g., engaging in activities that are recommended by teachers), a possibility which was not captured by the current measures of home math activities. These alternative explanations for the lack of relation between the home math activities and children's math performance in Grades 1-3 should be addressed by future research.

Gender and Home Math Activities

We found few associations between math activities and children's gender in this study. Mothers of children in Grades 1-3 reported doing more operational activities with their boys than with their girls. This result was not observed in kindergarten, nor in fathers' reports. Our findings do not illuminate the math-gender achievement gap that has long beset Chile, a country with one of the largest gender gaps in international testing (e.g., PISA, OEDC, 2019). Further research on children's experiences in the early years is needed to understand the source of the gender gap and generate effective actions to address it.

Limitations and Future Directions

The current study has several limitations. First, the study was cross-sectional. Longitudinal research is necessary to determine whether the patterns of relations between home math activities and children's math skills in the primary years change, and whether parents adjust their behaviors to their children's performance (Silinskas et al., 2020). Second, our study only included parent-report measures of the HME. Questionnaire and observational methods might yield different data and/or associations with children's skills (Bachman et al., 2020). Future research should combine parent-report data with direct observations and interviews to obtain a complete picture of the home math experiences of children in primary school (Hornburg et al., 2021). Third, the questions we asked may not have revealed the full range of activities that

parents engage in with their older children. Moreover, it could be that the questions we asked parents did not capture the math activities in which fathers could be engaging with their children at home. Fourth, the study did not include many schools at each SES level, and thus we cannot generalize the findings to the broader Chilean population. Inclusion of a middle-SES group is also an important consideration in future work. School SES was based on a vulnerability index that included several factors (i.e., students' living conditions, school performance, etc.), and was closely linked to parent education and parent fluency. In future, researchers could explore specific aspects of this index to better understand the SES effects. Fifth, because our study was correlational, the findings do not directly address the question of why school SES and maternal math fluency, but not the HME, was predictive of children's math skills in Grades 1-3. Intervention research is needed to disentangle the roles of the home and school factors in predicting children's math in kindergarten and primary school (Niklas et al., 2016).

Conclusions

The current research extends our knowledge of the relations between the home math environment and children's math skills in kindergarten and Grades 1-3. Mothers' formal home math activities predicted children's mathematical outcomes in kindergarten, but not in the primary grades, highlighting the need to further explore the HME of older children. In Grades 1-3, maternal fluency was a significant predictor of children's mathematical performance. Fathers' activities and math fluency were not related to children's performance beyond school SES. Together, these findings suggest the need to assess family and school factors to better understand children's math performance in the first years of primary school. These results also have implications for educational practice, as they highlight the math achievement gap between low- and high-SES Chilean students.

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Table 1

Means and Standard Deviations for Mapping and Operational Activities

	Kindergarten			Grade 1			Grade 2			Grade 3		
	Mean (SD)			*Mean (SD)*			*Mean (SD)*			*Mean (SD)*		
Activity	Mothers	Fathers	*t*	Mothers	Fathers	*t*	Mothers	Fathers	*t*	Mothers	Fathers	*t*
Operational Activities												
Encourage child to do math in his/her head	3.3(1.3)	3.2(1.1)	0.28	3.5(1.3)	3.4(1.2)	0.08	3.4(1.2)	3.3(1.3)	0.65	3.4(1.3)	3.3(1.3)	0.70
Help child learn simple sums (e.g., 2+2)	3.5(1.1)	3.2(1.1)	2.35*	--	--	--	--	--	--	--	--	--
Talk about time with clocks and calendars	3.3(1.1)	2.9(1.2)	2.64*	--	--	--	--	--	--	--	--	--
Play games/do activities where child counts, adds or subtracts	3.7(1.1)	3.4(1.0)	2.13*	--	--	--	--	--	--	--	--	--
Practice counting, adding, and subtracting in daily life	--	--	--	3.8(1.1)	3.5(1.2)	1.73	3.8(1.1)	3.3(1.3)	2.49*	3.8(1.0)	3.3(1.1)	2.85*
Encourage child to practice number facts (e.g., 2 + 3, 4 x 7)	--	--	--	3.6(1.3)	3.1(1.5)	2.62*	3.7(1.3)	3.1(1.4)	2.63*	3.4(1.3)	3.2(1.2)	0.76
Reliability (Cronbach's alpha)	.75	.81		.83	.82		.83	.85		.76	.83	
Mapping Activities												
Help child weigh, measure, and compare quantities	2.9(1.3)	2.9(1.1)	-0.35	2.7(1.2)	2.8(1.2)	-0.29	2.8(1.3)	2.6(1.2)	0.86	2.6(1.4)	2.5(1.3)	0.50
Ask about quantities (e.g., How many spoons?)	3.9(1.1)	3.5(1.1)	2.34*	2.6(1.5)	2.4(1.4)	0.98	3.3(1.3)	3.1(1.4)	0.90	3.1(1.5)	3.0(1.3)	0.39
Help child to recite numbers in order	3.9(1.1)	3.2(1.1)	4.92*	--	--	--	--	--	--	--	--	--
Sing counting songs	2.9(1.5)	2.3(1.2)	2.92*	--	--	--	--	--	--	--	--	--
Encourage the use of fingers to indicate how many	4.0(1.0)	3.3(1.1)	4.34*	--	--	--	--	--	--	--	--	--
Teach child to recognize printed numbers	3.9(1.1)	3.7(1.1)	1.36	--	--	--	--	--	--	--	--	--
Encourage counting by twos and threes, etc.	--	--	--	2.9(1.2)	2.8(1.4)	0.51	3.3(1.2)	3.2(1.2)	0.77	3.3(1.4)	2.8(1.4)	2.11
Teach child to print numbers	--	--	--	3.6(1.2)	3.2(1.3)	1.94	3.3(1.3)	2.8(1.5)	2.21	3.1(1.5)	2.6(1.5)	2.15
Practice answering, "How many?" without counting	--	--	--	2.9(1.4)	2.2(1.4)	3.59*	2.6(1.4)	2.3(1.3)	1.12	2.8(1.5)	2.4(1.3)	1.91
Use number or arithmetic flashcards	--	--	--	1.9(1.2)	1.8(1.2)	0.50	1.8(1.2)	1.8(1.1)	0.34	2.0(1.3)	1.7(1.1)	1.38
Reliability Mapping (Cronbach's alpha)	.77	.82		.76	.79		.83	.84		.87	.78	
Teach multiplication tables[a]	--	--	--	--	--	--	2.8(1.3)	2.6(1.4)	0.62	3.2(1.3)	2.8(1.3)	2.09*
Ask about fractions (e.g., sharing portions)[a]	--	--	--	--	--	--	2.3(1.3)	2.3(1.2)	0.20	2.5(1.4)	2.4(1.2)	0.80

Note. Parents responded on a five-point scale, where 1 = rarely or never, 2 = monthly, 3 = weekly, 4 = several days a week, and 5 = most days per week. '--' indicates that the item was not given to that age group, and *indicates $p < .05$ after Benjamini-Hochberg corrections for false detection rates. [a] Item not included in further analyses because it was not

given to children in all primary grades.

Table 2

Correlations and Descriptive Statistics for Parent Factors and Child Outcomes: Kindergarten

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. School SES	--												
2. Child's Gender	-.13	--											
3. Mother's Education	.71**	-.11	--										
4. Mother's Math Fluency	.45**	-.07	.55**	--									
5. Mother's Number-Game Score[a]	-.21*	-.09	-.22*	.04	--								
6. Mother's Mapping Activities[b]	-.07	-.01	.02	-.01	.04	--							
7. Mother's Operational Activities[b]	-.15	.02	-.08	.03	.11	.52**	--						
8. Father's Education	.66**	-.05	.79**	.37**	-.16	.12	-.03	--					
9. Father's Math Fluency	.45**	-.05	.53**	.29**	-.22*	.01	-.13	.57**	--				
10. Father's Number-Game Score[a]	.23*	.14	.16	.04	-.11	.01	-.05	.25*	.23*	--			
11. Father's Mapping Activities[b]	.09	-.14	.01	-.01	-.01	-.09	-.01	.06	.07	.22*	--		
12. Father's Operational Activities[b]	.07	-.15	.09	-.03	-.03	.05	.16	.13	.15	.18	.75**	--	
13. Math Outcomes[c]	.23*	.04	.25*	.26**	.06	-.14	.19	.24*	.10	.24*	.16	.23*	--
N	101	101	101	101	100	101	100	98	99	98	99	99	100
Mean	0.51	0.48	7.70	89.60	0.00	3.57	3.45	8.18	96.85	0.00	3.14	3.17	0.00
Standard Deviation	0.50	0.50	3.00	25.78	1.00	0.80	0.88	2.92	28.26	1.00	0.81	0.87	1.00
Z-Skew	-	-	1.99	2.25	-2.75	-.245	-1.87	**-4.43**	-1.15	2.66	0.46	0.63	1.05

Notes. [a]standardized z-score [b]mean score [c]factor/latent score; **bolded** skew indicate z-skew > |3.29|; Gender was coded as 0=female and 1=male; School SES was coded as 0=low and 1=high.
*$p < .05$. **$p < .01$.

Table 3

Correlations and Descriptive Statistics for Parent Factors and Child Outcomes: Grades 1-3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Grade of Child	-													
2. School SES	-.11	--												
3. Child's Gender	-.08	.00	--											
4. Mother's Education	-.14*	.65**	.01	--										
5. Mother's Math Fluency	-.03	.52**	.03	.60**	--									
6. Mother's Number-Game Score[a]	.20*	-.07	.01	-.07	-.05	--								
7. Mother's Mapping Activities[b]	.02	-.29**	.11	-.26**	-.20**	-.02	--							
8. Mother's Operational Activities[b]	-.03	-.01	.15*	.05	.04	.00	.63**	--						
9. Father's Education	-.12*	.64**	.09	.64**	.51**	-.12	-.31**	-.05	--					
10. Father's Math Fluency	.05	.53**	-.03	.45**	.48**	.02	-.20**	-.07	.61**	--				
11. Father's Number-Game Score[a]	-.04	.16*	.04	.19**	.25**	.06	-.06	.01	.30**	.32**	--			
12. Father's Mapping Activities[b]	-.01	-.20**	-.02	-.18**	-.15*	.01	.26**	.19**	-.15*	-.17**	-.06	--		
13. Father's Operational Activities[b]	-.03	.02	.04	.03	-.01	-.01	.18**	.27**	.14*	.07	.12	.69**	--	
14. Math Outcomes[c]	.64**	.23**	.03	.15*	.27**	.11	-.03	.07	.15*	.22**	.09	-.03	.08	--
N	266	266	266	265	266	265	266	266	264	266	266	266	266	261
Mean	1.96	0.44	0.52	7.24	89.15	0.00	2.80	3.59	7.03	91.26	0.00	2.56	3.29	0.00
Standard Deviation	0.82	0.50	0.50	2.96	28.00	1.00	0.96	1.04	3.07	27.75	1.00	0.98	1.10	1.00
Z-Skew	-	-	-	-2.51	1.31	**6.31**	0.85	**-4.49**	-1.97	-1.23	**-3.94**	2.08	-2.89	0.89

Notes.; [a]standardized z-score [b]mean score [c]factor/latent score; **bolded** skew indicate z-skew > |3.29|; Gender was coded as 0=female and 1=male; School SES was coded as 0=low and 1=high.

*$p < .05$. **$p < .01$.

Table 4

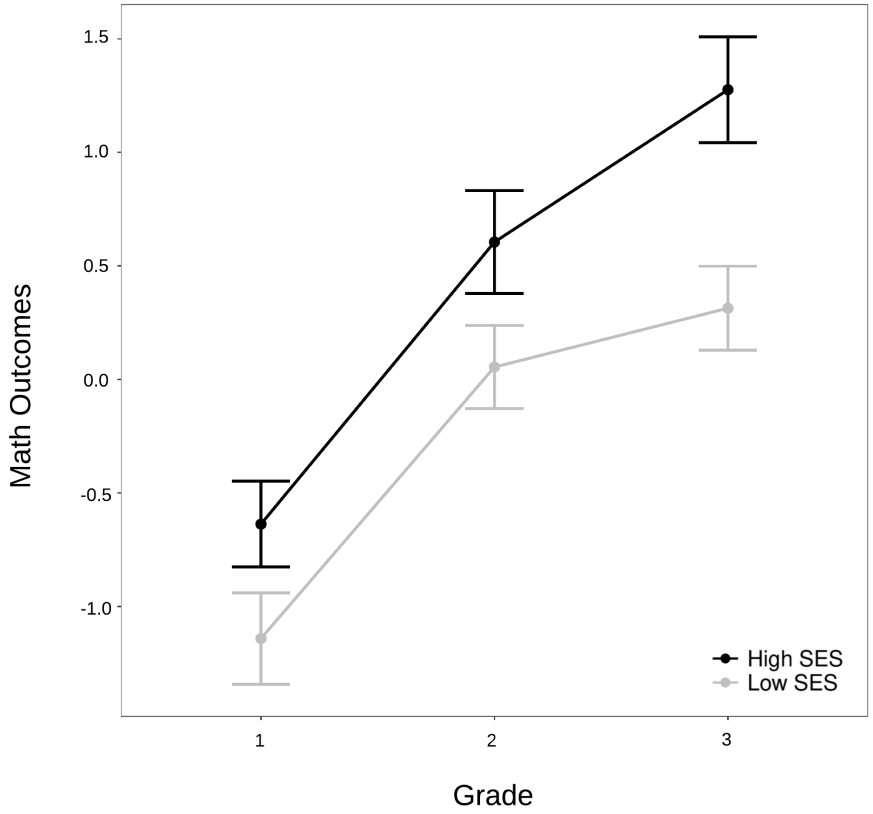
Math Outcomes Regression Analyses for School SES, Parent Factors, and the Home Math Environment

	Mothers				Fathers			
	Kindergarten (*n* = 97)		Grades 1-3 (*n* = 258)		Kindergarten (*n* = 95)		Grades 1-3 (*n* = 258)	
	β	*p*	B	*p*	β	*p*	β	*p*
Model 1								
Grade in School	--	--	**.578*** **	**.000**	--	--	**.578*** **	**.000**
School SES	**.232***	**.023**	**.174****	**.008**	**.232***	**.025**	**.174****	**.008**
Grade by SES	--	--	**.202****	**.006**			**.202****	**.006**
Child's Gender	.065	.524	.081	.063	.044	.663	.081	.063
ΔR^2	*.054*	*.072*	***.529*** **	***.000***	*.054*	*.078*	***.529*** **	***.000***
Model 2								
Grade in School	--	--	**.562*** **	**.000**	--	--	**.576*** **	**.000**
School SES	.103	.474	**.**083	.254	.147	.292	.138	.070
Grade by SES	--	--	**.216****	**.003**	--	--	**.201****	**.007**
Child's Gender	.063	.533	.074	.079	.039	.702	.078	.075
Parent Education	.080	.600	-.031	.610	.201	.175	.034	.591
Parent Math Fluency	.160	.178	**.193*** **	**.000**	-.105	.396	.028	.487
ΔR^2	*.029*	*.233*	***.024*** **	***.003***	*.020*	*.371*	*.002*	*.626*
Model 3								
Grade in School	--	--	**.563*** **	**.000**	--	--	**.582*** **	**.000**
School SES	.105	.454	.089	.224	.156	.255	**.153***	**.047**
Grade by SES	--	--	**.221****	**.003**	--	--	**.196****	**.008**
Child's Gender	.057	.554	.063	.141	.090	.379	.074	.091
Parent Education	.179	.229	-.035	.577	.150	.303	.006	.931
Parent Math Fluency	.096	.409	**.192****	**.001**	-.143	.245	.013	.829
Shared Number-Game	.090	.368	-.012	.780	.164	.123	.045	.337
Mapping Activities	**-.322****	**.006**	.020	.733	-.074	.636	-.031	.626
Operational Activities	**.379****	**.001**	.065	.261	.256	.107	.096	.135
ΔR^2	***.123*****	***.005***	*.006*	*.321*	*.071*	*.071*	*.008*	*.230*
Total R^2	**.206****	**.003**	**.559*** **	**.000**	**.145***	**.049**	**.538*** **	**.000**

Notes. β is the standardized regression coefficient. Bolded numbers indicate $p < .05$.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 1

Interaction Between School SES and Grade Predicting Math Outcomes of Children in Grades 1-3



Note. This graph shows the interaction between children's grade in school (from Grade 1 to Grade 3) and school SES (low- and high-SES) in predicting math outcomes. The differences in performance between low- and high-SES students is larger in Grade 3 than in Grades 1 and 2.