

Socioeconomic Status and Children's Math Proficiency Development: The Role of Parental Math Expectation, Investment, and Involvement

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ABSTRACT

Parental investment mechanisms underlying the relations between socioeconomic status (SES) and primary math proficiency are not well-understood. Using the lens of parental expectation, parental investment and parental stress model, present study narratively reviewed relevant literature on parental math expectation, math investment and math involvement that mediates the relations between SES and primary math proficiency. Evidence suggests that compared to high-SES parents, low-SES parents have low math expectation, poor math investment and math involvement by which low-SES influences poor math proficiency development over the primary schooling. Further research is necessary to confirm the parental investment pathways by which low-SES compared to high-SES influences children's poor math proficiency during primary grades.

Keywords: Socioeconomic Status, Parental Math Expectation, Parental Math Investment, Parental Math Involvement, Children's Math Proficiency Development

INTRODUCTION

This review examines how socioeconomic status (SES) impacts the math proficiency growth of children in primary education, with the aim of developing a conceptual model based on expectation theory, family investment model, and family stress model. Actually, mathematics is a hierarchical subject in which children's early math knowledge and skills (e.g., number sense, patterns, principles, & operations) lay the foundation for later math proficiency development and achievement (Uddin, 2024). According to Baroody (2006), math proficiency refers to the operative skills by which children accurately solve math questions or math problems, using any efficient strategy not just retrieval. Growing research indicates that children from low-SES grow up with poor math knowledge and proficiency than their high-SES peers. This poor math proficiency emerges early childhood (age 0-5) and is persistent throughout later childhood (age 6-8) or even adolescence. In the United States and internationally, empirical research has found that children from low-SES families achieve 20-40% lower scores than their high-SES counterparts by the early primary grade. This discrepancy in math proficiency growth is persistent throughout the primary schooling (Uddin, 2022, 2023b; Duncan & Magnuson, 2011; Jordan, Huttenlocher, & Levine, 1992, 1994; Jordan, Levine, & Huttenlocher, 1994; Rittle-Johnson, Fyfe, Hofer, & Farran, 2017; Reardon & Portilla, 2016; Taylor, Dearing, & McCartney, 2004). Much less is known about how low-SES influences family processes and children's math proficiency growth over time (Uddin, 2017b, 2024).

Low-SES has detrimental effects on children's early cognitive and math proficiency growth if parents do not have sufficient psychological, social and economic resources to maintain parenting practices and consistent spending on goods and services that promote children's healthy development and academic growth, including math proficiency development (Uddin et al., 2023g). Extant research shows that persistent low-SES in comparison to high-SES leading to parents' poor math expectation (Diemer, Mistry, Wadsworth, López, & Reimers, 2013), fewer investments and lower involvement could be detrimental for children's math proficiency growth, depending on their age, sex and context. While a vast majority of the literature in the US and internationally has partially examined parental expectation, investment, and involvement in children's math development and school achievement (Conger & Donnellan, 2007; Gutman & Eccles, 1999; Linver et al., 2002; Simons et al., 2016; Simons et al., 2020; Yeung et al., 2002), less review research to date has integrated underlying these potential mechanisms or pathways to understand relationship between SES and math proficiency growth among primary school children. Based on parental expectation theory (PET), parental investment model (PIM), and parental stress model (PSM), present paper addresses these challenging questions and accordingly develops a coherent theoretical framework and a set of testable hypotheses related to low-SES and children's math proficiency growth. Using systematic approach, this theoretical framework and literature helps understand mechanisms or pathways such as parents' math expectation, math investment and math involvement together fully explain the association between low-SES and poor math proficiency development among primary students across the globe, particularly in the US and in the developing countries (Long & Pang, 2016; Uddin et al., 2023h). This theoretical explanation and evidence is informative for early interventions to improve low-SES children's math proficiency development (Chittleborough et al., 2014). In the second section, we describe methodology of the review. Drawing from the integrated theoretical framework, the third section explains the mechanisms or pathways from low-SES to math proficiency development among primary students in the US and in the developing countries, including Bangladesh. In the fourth section, limitations and directions for future research, as well as policy implications are presented, whereas the fifth section presents concluding remarks.

METHODOLOGY

A systematic literature review was conducted to analyze the on the research questions: 1) Does low-SES is significantly related to poor math proficiency growth among primary students in the US and internationally? 2) Does parents' poor math expectation mediate the association between low-SES and poor math proficiency growth among primary students? 3) Do parents' fewer math investments mediate the association between low-SES and poor math proficiency growth among primary students? 4) Does parents' lower frequency of math involvement mediate the association between low-SES and poor math proficiency growth among primary students? In so doing, the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) was used to select relevant studies for detailed review. The PRISMA approach consists of four steps such as identification, screening, eligibility and inclusion for publication selection that have explained below:

1. Identification stage: The systematic search term was conducted in Google Scholar, Scopus and Web of Science to identify relevant literature. In so doing, the following search terms were used: "Socioeconomic Status", "Primary Math Proficiency Growth/Development", "Children's Primary Math Achievement", "Parental Expectation Model", "Parental Investment Model", "Parental Stress Model", and "Family Involvement Model or Parenting Practice Model" in title, abstract and keywords for potential publication. In this paper, the peer review publications were selected and initially we found 500 publications during 1990 through 2020.
2. Screening stage: In this stage, initially selected publications were screened by removing duplication and narrowing search items, following inclusion and exclusion criteria, following relevancy for research questions. Consequently, 150 relevant publications in sociology, educational psychology and social science research journal were selected.

3. Eligibility check: In this stage, the selected screened publications were further checked for eligibility to be included in the review analysis, following inclusion and exclusion criteria. Particularly, we included the publications that were indexed in Scopus or Web of Science databases. Subsequently, we found 124 publications eligible for review analysis.
4. Inclusion stage: In this stage, the eligible publications with full-text accessibility were included for review purpose. Finally, 66 full-text accessible articles from the US (n= 45) and developing countries (n= 21) were included for data extraction.

Pathways by Which Socioeconomic Status Links to Primary Math Proficiency

The key to developing social policy and programs that effectively provide supports young children lies in understanding family processes by which low-SES than high-SES is associated with poor math proficiency during first grade through fifth grade (Uddin, 2017c, 2023a). Family investment model and research in the US posits that low-SES parents than their high-SES peers have limited educational expectations to their children (Uddin et al., 2023f). Low-SES parents than their counterparts are less able to provide home enriching materials for children's early cognitive development. In addition, they have lower frequency of involvement in home-numeracy activities. In turn, these poor parental investments and involvements negatively influence lower-SES children's math proficiency development throughout the schooling (Duncan, Magnuson, & Votruba-Drzal, 2014; Uddin, 2023c, 2023d). According to Lareau (2003), high-SES parents frequently engage in organized, intentional activities that foster children's development and achievement, while low-SES parents typically involve in practices that allow for the accomplishment of their children's natural growth. Particularly, family stress model suggests that in the families where socioeconomic resources (e.g., income & education) are scarce, parents often feel stress, resulting in strained relations, family discord and emotional distress which, in turn, disrupt daily parenting practices and regular engagement in children's learning inside and outside the home (Conger & Dogan, 2007; Conger & Donnellan, 2007). Taken together, these theories and research explain 10-40% variance in the association between SES (e.g., income and education) and children's math proficiency development during kindergarten through third grade. Based on theories and research, present study delineates three specific pathways: 1) parental math expectation (PME), 2) parental monetary investment (PMI) in home-enriching materials, and 3) parental educational involvement (PEI) in home-numeracy activities (PIHNAs) through which low-SES (e.g., family income, maternal & paternal education) than high-SES might negatively influence children's primary math proficiency development. We next describe theoretical relevance and empirical underpinnings on the specific pathways through which low-SES is more likely than high-SES to affect children's poorer math proficiency development during first-grade through fifth-grade (see, Figure 1).

Parental Math Expectation

In psychological research, there is widely believed that parental higher expectations foster children's long-term educational success, while parental lower expectations impede children's education. Family researchers derived assertion from parental expectation theory view that family income shapes parental expectations not only for children's future but also for their educational achievement (Diemer et al., 2013). PIM and research have hypothesized that low-SES parents are viewed to be lower educational expectations for their children, while middle- and high-SES parents hold higher educational expectations for their children's better chances and educational attainments (Schneider & Stevenson, 1999). Although empirical evidence supports this hypothesis in the US and internationally, little research is conducted in South Asian regions, particularly in Bangladesh. For example, the seminal research by Sewell and Hauser (1975) found strong relation between family income, parental expectations, and children's educational outcomes. Likely, Davis-Kean (2005) found that parental education and family income fostered parental expectations, which in turn were predictive of children's achievement. Zhan (2006) examined the association of parental assets and their expectations and involvement in children's education, influencing educational performance. Using mother-child data set from the National Longitudinal Survey of Youth (NLSY79), the results indicate that

parental assets were positively related to children’s math and reading scores, after accounting for family characteristics. Parental assets were also positively associated with their expectations and involvement of school activities. Particularly, parent expectations partially mediated the relationship between assets and children’s educational performance, including mathematics.

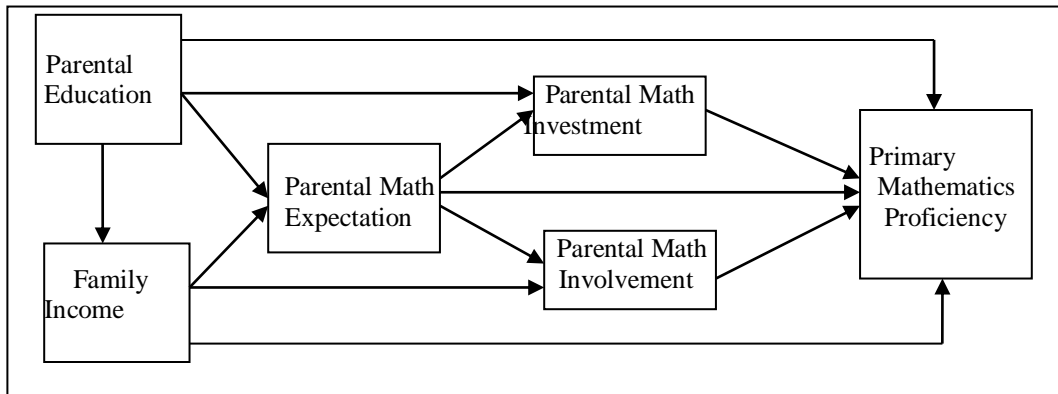


Figure 1: Hypothesized model

The Eccles’ expectancy-value model posits that a cascade of mechanisms explain associations between parents’ beliefs and youths’ achievement-related behaviors. Specifically, parents’ beliefs predict parents’ behaviors; in turn, parents’ behaviors predict youths’ motivational beliefs, and youths’ motivational beliefs predict their behaviors (Simpkins et al., 2012). A study by Simpkins et al. (2012) tests this model with mothers in sports, music, math, and reading over a 12-year period. Data were drawn from mother, youth, and teacher questionnaires collected as part of Childhood and Beyond Study (92% European American; $N = 723$). Mothers’ beliefs in sports, music, and math positively predicted their behaviors in these areas 1 year later, which predicted youths’ self-concepts of ability and values (i.e., their motivational beliefs) in these domains 1 year later. Adolescents’ motivational beliefs predicted time spent in organized sport activities, playing music, and reading after school measured 4 years later as well as the number of math courses taken in high school. Furthermore, except in reading, mothers’ behaviors mediated the relations between mothers’ and youths’ beliefs, and youths’ beliefs mediated the relations between mothers’ behaviors and youths’ behaviors. Although there were mean-level differences in several indicators based on child gender, in most cases the relations among these indicators did not significantly vary by child gender. This study highlights the processes by which mothers’ beliefs during their children’s childhood can predict children’s activities in adolescence. Wang and Benner (2014) explored how discrepancies between parents’ and adolescents’ educational expectations influenced adolescents’ academic achievement in a nationally representative, longitudinal sample of 14,041 students (14 years old at baseline). They examined actual discrepancies and perceived discrepancies were examined. Achievement was higher when parents actually held higher expectations than adolescents held or when adolescents perceived that their parents’ expectations were lower than their own. In contrast, achievement was lower when parents actually held lower expectations than adolescents held or when adolescents believed that their parents’ expectations exceeded their own. Using a longitudinal mediation framework and a low-income sample, Loughlin-Presnal and Bierman (2017) explored bidirectional associations between parent academic expectations and child academic outcomes from first through fifth grade, via parental influence: parent involvement in child schooling, child learning behaviors, and child perceived academic competence. They included 356 children and their caregivers (89% mothers) from Head Start centers (58% European American, 25% African American, 17% Latino). At each time point (grades 1, 2, 3, 5), parents rated their academic expectations, teachers rated parent involvement and child learning behaviors, and children rated their self-perceptions of their academic competence. In this study, bidirectional longitudinal associations emerged between parent academic expectations and child academic outcomes. Child learning behaviors mediated this association from first to third grade, whereas child perceived academic competence mediated from second to fifth grade. In a meta-analysis Pinquart and Ebeling (2020) assessed

concurrent and longitudinal associations between parental educational expectations and child achievement, and the factors that mediate the effect of expectations on achievement. Using systematic search in electronic databases, they identified 169 studies that were included in a random-effects meta-analysis. They found small to moderate bivariate cross-sectional ($r = .30$) and longitudinal associations ($r = .28$) between parental expectation and achievement which persisted after statistically controlling for socioeconomic status. The analysis of cross-lagged effects indicated that parental expectations predicted change in child achievement, thus indicating that expectations had an effect over and above the effect of prior achievement. Effects of expectations on change in achievement were even stronger ($r = .15$) than the effects of achievement on change in expectation ($r = .09$). Parental expectations tended to be higher than the child achievement. Associations between expectations and achievement were partially mediated by educational expectations in the offspring, child academic engagement, and academic self-concept, and to a lesser extent, by parental achievement supportive behaviors. We conclude that parents are recommended to communicate positive educational expectations to their children. The transmission of positive expectations to the offspring and the encouragement of academic engagement seem to be more effective in realizing parental expectations than parental behavioral academic involvement such as checking homework and staying in contact with teachers. Several studies have also explored gender and ethnic differences in SES and parental expectation in children's math achievement over time (Trusty et al., 2003).

Parental Math Investment

Parental investment in provision of home enriching and stimulating materials (e.g., number books, toy, calculator, tape or record player, computer, board, card etc.) that enhances children's early cognitive and math development at home and later math achievement at school is the most fundamental form within the broader framework of the FIM. These specific investments by parents are hypothesized as mechanisms through which family SES disparities affect children's cognitive and math achievement over time (Bradley, Corwyn, McAdoo, & GarcíaColl, 2001; Guo & Harris, 2000; Gershoff, Aber, Raver, & Lennon, 2007; Hamilton, 2012). Although longitudinal research on the specific forms of the PMI in children's early cognitive and math development is very limited in South Asian (Black, 2003; Das & Padhee, 1993) and Bangladesh context (Hamadani et al, 2010; Uddin, 2021), a large body of research in the US and internationally supports the hypothesized pathways from family SES to children's early cognitive and math development and later PMA (Bradley et al., Elliott et al., 2018). In the US, several longitudinal studies have found that parents' provision of home enriching and cognitively stimulating materials that directly enhance children' cognitive, language, and math development (e.g., number sense) during early childhood partially mediate the relations between income and math achievement, such that low-SES children than their counter peers have less access to learning materials in the home that impede their early math development and later poorer math proficiency throughout elementary school years, after controlling child and family characteristics (Bradley et al., 2001; Cheadle, 2008; Coley, Sims, & Votruba-Drzal, 2016; Davis-Kean, 2005; Guo et al., 2000; Gershoff et al., 2007; Galindo & Sonnenschein, 2015; Kornrich & Furstenberg, 2013). Experimental studies also have found that changes in family income during early to middle childhood are associated with changes in children's math enriching and stimulating materials in the home that are causally related to later math achievement, after adjusting for family structure and employment (Dearing, McCartney, & Taylor, 2001; Elliott et al., 2018; Votruba-Drzal, 2003).

Parental Math Involvement

Parental involvement in children's early math learning activities (e.g., number talk, counting practice, reading number books, playing board games & talking about money with children etc.) in the home (LeFevre et al., 2009) that enhances early math learning and later math achievement is another fundamental form of the FIM. Parents' involvements in the domains of children's early math development are also hypothesized as important pathways through which family SES affects children's math proficiency throughout the elementary school years. Although the hypothesized pathways of parental involvement in children's early math learning

activities through which low-SES is more likely than middle- and high SES to affect math proficiency throughout elementary school years are well-documented in the US (Cooper, Robinson, & Patall, 2006; Elliott et al., 2018; Huntsinger, Jose, & Luo, 2016; Milkie, Nomaguchi, & Denny, 2015; Nomaguchi, Milkie, & Denny, 2016; Pezdek, Berry, & Renno, 2002; Villena-Rodan and Rios-Aguilar, 2011), very little is known about parental involvement in children's early math development and later math achievement in South Asian and Bangladesh context. In the US, Saxe, Guberman, & Gearhart (1987) in a seminal work observed differences in the frequency of parents' math activities in the home in a sample of 2 and 4 years old children and found that working-class parents were less engaged in the different types of math activities than middle-class parents, such that working-class parents were less time spent with children's math activities than the middle-class parents in the home that affect poorer math achievement. Deflorio & Beliakoff (2015) also found small but significant differences in parents' self-reported math activities in the home between lower-class and middle-class parents. Of 13 math activities, lower-class parents on average had different frequency exposure (1.1-1.3) than middle-class parents to math content at home during early childhood. Tudge & Doucet (2004) observing 3-year old children and their parents found that PTI in children's math activities (e.g., discussion of math content, playing with books or toys that include numbers) differed children's math achievement between the middle- and lower-class families. Pezdek et al. (2002) found that compared to lower-income parents, higher-income parents spent more amount of time (on average 1.14 hours a week) with children in their math homework that enhances children's mathematics achievement during fourth grade through sixth grade. Cooper et al., (2006) also found that higher-status parents' time investments in their children's math homework and math preparation than lower-status parents at home had better elementary math achievement. LeFevre et al. (2009) examined parental four factors of math activities (e.g., playing math game, math application in everyday activities, activities that develop math skills & number of books) across the income groups and found that more amount of time spent of higher-income parents than lower-income parents with their children's math activities were positively related to early math fluency and later math achievement in 5-8 years old children. Huntsinger et al. (2016) found that time spent with children's formal math activities (e.g., filling out math workbooks, and counting and adding on fingers) positively predicted math skills, whereas frequency of informal time spent to children's math activities (e.g., playing with math board games, card games & puzzles) were negatively related to math learning for 4-5 years old children.

Experimental and intervention research also has found that improvement in family income during childhood are associated with more amount of PTI in children's math activities in the home that are causally reduced early math abilities and later math achievement gaps between lower-income and middle-income children (Elliott et al, 2018; Jordan et al., 1994). For example, Scalise, Daubert, & Ramani, (2020) randomly assigned to play a numerical magnitude comparison card game, a numerical memory and matching card game, or a shape and color matching card game across 15-minutes sessions among low-income preschoolers (N=76) and found that children who played either of the numerical games improved their numerical identification skills, while only children who played the numerical magnitude comparison game improved their symbolic magnitude comparison skills.

DISCUSSION

In this paper we systematically reviewed literature (during first grade through fifth grade) to examine parents' math expectation, math investment, and math involvement as potential mechanisms linking low-SES to primary math proficiency growth. In the US and internationally, evidence in the literature suggested that parents' low-SES in comparison with high-SES counterparts directly and significantly predicted poor math expectation, fewer investment and lower involvement in math learning activities. These family process factors, in turn, significantly increased poor primary math proficiency growth among children (Simons et al., 2020). The evidence indicated partial support for the PEM, PIM and PSM, hypothesizing multiple pathways by which low-SES influences children's poor math proficiency. Although the direct associations of low-SES and poor math proficiency growth during first grade through fifth grade were statistically significant, some of the associations were accounted for by three potential mechanisms or pathways: parents' poor math

expectation, fewer math investments and lower math involvement in children's math education over time. In the US, some longitudinal studies and meta-analyses reveal that parents' math expectation and math involvement are more potential mechanisms than fewer math investments by which low-SES exerts negative effects on children's math proficiency growth over time (Davis-Kean, 2005; Galindo & Sonnenschein, 2015; Loughlin-Presnal & Bierman, 2017). In developing countries, some descriptive studies have found that fewer monetary investments by low-SES parents have more detrimental effects than math expectation and educational involvement on children's primary math proficiency growth in urban context (Uddin et al., 2023h, Uddin, 2024).

Evidence from articulating three key mechanisms from the family process models linking low-SES to children's lower math achievement might provide a solid foundation for early interventions and policies aimed at improving family SES and child development and math achievement. Policy-makers and stakeholders (e.g., local and international agencies) should take multiple programs (e.g., poverty reduction, psychosocial therapies for distress reduction, resocialization, and educational support) to improve low-SES children's development and achievement associated with family processes around the world (Dubow & Ippolito, 1994; Dearing, McCartney, & Taylor, 2001; Uddin, 2024). Several intervention studies have found that improving family SES increases parents' educational expectation and monetary abilities to purchase necessities and provide educational materials to their children in the home. Improving SES also reduces parental stress and distress and likely increases their educational involvement. In turn, all these improved psychosocial factors of the parents positively foster children's math growth over time (Votruba-Drzal, 2003; Uddin et al., 2023d).

LIMITATIONS AND METHODOLOGICAL IMPLICATION

Using theoretical model and systematic literature review, evidence of the present paper, showing strong effects of low-SES on children's poor math proficiency growth via parental math expectation, fewer monetary investments, parental stress/distress and negative parenting practices, contribute to the field (Duncan et al., 1997, Duncan et al., 1998). Despite this strength, the current paper has some limitations. *First*, the evidence of the study was mostly extracted from Western and European literature and some from developing countries. So, we cannot generalize the evidence across the world contexts, including sociocultural status, ethnic families and children. *Second*, although we proposed an integrated causal mediation model and then we systematically reviewed literature on low-SES, three family process mechanisms and children's primary math proficiency growth, the lack of longitudinal research (e.g., three or more waves of data on each variable) may make difficult to establish the causal direction of the mediating mechanisms from low-SES to poor math proficiency growth over time (Cole et al., 2003). *Third*, although the family process models have multi-dimensional pathways, lack of interdisciplinary scientific research with standardized methodology prohibit understanding the pathways of low-SES to children's math growth over time (Maxwell et al., 2011). In the low and middle income countries (LMICs), several studies have found that children growing up in the resource constraint households and low socioeconomic status have less access to material and cognitive resources, as well as parents' less involvement in children's academic math achievement (Uddin, 2015, 2023e; Bornstein et al., 2012; Bornstein et al., 2015). Additional research is needed to examine parental investments and parental involvement in children's primary education, particularly in Bangladesh where chronic family poverty impede children's healthy development and academic achievement. Future studies should consider these short-comings to analyze how low-SES via family processes affects children's math proficiency growth across the societies, particularly from developing and the least developed countries (Cole et al., 2003; Maxwell & Cole, 2007; Maxwell et al., 2011).

CONCLUSION

Based on theoretical framework and systematic approach, the present paper reviewed literature to understand family process mechanisms by which low-SES imparts negative effects on child development and primary

math proficiency growth over time. The evidence in the systematic literature review suggested that although all mediators contribute to the theoretical framework, parental low math expectation, psychosocial distress and negative parenting behaviors (Evans et al., 2001; Gutman et al., 1999; Gershoff et al., 2007) than poor math investments are critical mechanisms by which low-SES negatively influences children's poor math development, after accounting for background characteristics. The present evidence consistent with the theoretical frameworksuggested is informative for social policy implications (e.g., economic support and training for parenting practice) and early interventions to improve disadvantaged children's math proficiency achievement (Uddin, 2023a) around the world. Several intervention studies have found that improving SESincreases parents' educational expectation, monetary abilities to purchase necessities, reduce parental psychosocial distress, and change negative parenting that, in turn, will positively foster disadvantaged children's math development (Duncan et al., 2011; Dahl & Lochner, 2008). In addition, increased economic support for lower-income families also save parents' times to support for and involvement in their children's learning activities (e.g., homework, reading,) at home and to monitor children's behavior that, in turn, will enhance primary mathproficiency development (Uddin, 2023c).

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