The Effects of Parent's SES and Education Level on Students' Mathematics Achievement: Examining the Mediation Effects of Parental Expectations and Parental Communication

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ABSTRACT

Although there has been prior research concerning parental involvement effects on students' mathematics achievement, little attention has been placed on the reasons for the mathematics achievement gap between low-and middle-income students, and how to reduce this gap associated usually attributed to students' SES. The present study's focus is specifically on parent-child communication and parental expectations mainly because these two variables can increase students' mathematics achievement despite parental income and education level. The correlation matrix was derived from a national, cross-sectional study of children. The 1997 Child Development Supplement of the Panel Study of Income Dynamics (PSID-CDS) data set was used to analyze the hypothesized model using SEM. The goodness-of-fit indices for the hypothesized model fit well to the data.

Keywords: *mathematics achievement, mediation effects, parental expectations, parental communication*

INTRODUCTION

Research about the effects of parental involvement on students' mathematics achievement have revealed that parent's SES and parent's education level play an important role on their children's early and later mathematics achievement (Crosnoe & Cooper, 2010; Clements & Sarama, 2007; Jordan, Kaplan, Locuniak, & Ramineni, 2007). Davis-Kean (2005) noted, however, that the effects of parents' educational level and SES background have not been investigated in a coherent manner because previous studies have found that the effects of these variables on children's mathematical achievement can possibly be explained by other parental variables. For example, Smith, Brooks-Gunn, and Klebanov (1997) found that the correlation between children's mathematics achievement and parental background (namely parent's SES and education level) was mediated by the educational environment at home. Additionally, the mediation effects were higher on parent's educational level than parent's SES. Halle et al. (1997) sampled from parents with low-SES backgrounds, and reported that children's mathematics success was related to parents' educational level. The reason for this relationship was because highly educated parents held more positive feelings towards mathematics and set higher success expectations from school than less educated parents (Halle, Brooks-Gunn, & Klebanov, 1997). Alexander, Entwistle and Bedinger (1994) demonstrated that although parents with low-SES backgrounds set high expectations, there was no correlation between their children's mathematics achievement and their high-expectations; however, there was a correlation between parents with high-SES backgrounds and their children's mathematics achievement. This does not mean that low-income and less educated parents are not concerned about their children's mathematics achievement, but the reason is that they themselves do not feel ready to assist their children because of their own limited educational and financial resources (Clements & Sarama, 2007). Padavick (2009) found that children's mathematics achievement can be increased even when parents read books to their children at an early age, and this early active involvement develops not only

students' mathematical understanding but also their later social interaction. Therefore, research is needed with specific attention to parent-child communication and parental expectations because these two variables can be changed in a way that can help to develop children's mathematical achievement. At first glance, it appears that schools and teachers might be incapable of changing parental attitudes, but thanks to the efforts of educators through educational research's implementations, it is possible to increase parental expectations, beliefs and parent-student relationships (Yan & Lin, 2005). Therefore, the aim of the present study was to determine how parent-child communication and parental expectations play a role in explaining children's mathematics achievement regardless of their parents SES and educational background level.

Literature Review

Home experiences are vital in shaping children's future mathematical interests, beliefs, and motivations. The role of parents in shaping their children's future mathematics' attitudes and motivation is especially key during early childhood. Iruka and Barbarin (2008) noted that parents and families are considered the most essential others who children encounter in the earliest stage of their lives. The reason why parents are considered the most essential others in their children's early and later lives is because children observe and learn from, and later apply as parallel their early observations. Because each parent provides different experiences at home, the observations of each child results in differences related to their parents' attitudes, values, and beliefs about mathematics. All of these parental behaviors lead to different educational emphases in the home (Cross, Woods, & Schweingruber, 2009). To provide more positive educational experiences at home, parents need to be informed about how their involvement affects their children's mathematical skills and knowledge.

Friedel, Cortino, Turner, and Midgley (2010) noted that parental involvement in its many and varied ways is a vital parameter for increasing children's mathematics achievement. Current studies have indicated some specific factors that play an essential role in increasing children's mathematics achievement: Parental aspirations, parent-child communication, home structure, and parents' involvement in school's activities (Singh, Bickley, Keith, Trivetta, Keith, & Anderson, 1995; Wang, 2004). Bicer, Capraro, and Cetin (2010) noted similar indicators affecting children's mathematical achievement either adversely or positively: parents' SES, parents' success expectations from their children's mathematics courses, parental beliefs about mathematics, and parent-child, teacher and school communication.

Parents' SES and Educational Background Effects on Mathematics Achievement

Students who come from low-SES backgrounds enter school far behind their peers who come from higher-SES backgrounds and understand less mathematical topics including but not limited to counting, and number relations (Jordan et al., 2007). Although there has been much research about parental involvement effects on students' mathematics achievement, little attention has been placed on the reasons for the mathematics achievement gap between low-and middle-income students, and how to reduce this SES gap. Cross et al. (2009) further added that there was a huge mathematics achievement gap between low-and middle- SES students even before they enrolled in elementary school, suggesting that low-SES parents can support their children's informal mathematical knowledge and skills by enhancing their readiness before they start school; thus reducing the gap between low-SES students and high-SES. However, this support may be improved by providing information about early and later mathematical development, and its connection to parental support (Starkey & Klein, 2000). Once parents believe their support is of importance to their children' s mathematical development, they will try to provide as many opportunities as they can (Bicer, et al., 2010), and students who have had opportunities at home to learn mathematics demonstrated more mathematical achievement than their peers who lacked such opportunities. Zadeh, Farnia and Ungerleider (2010) showed that providing an enriched home environment was essential for the reading and mathematics achievement of both boys and girls, and they indicated that providing an enriched home environment was one of the options available to influence children's mathematics achievement, particularly that of children of less well-educated mothers. Crosnoe and Cooper (2010) noted that the achievement gap due to the students' economic background was larger for reading but more related to family socialization factors in mathematics.

> Children had smaller gains on the math and reading tests between their kindergarten and first-grade years with each additional marker of family economic disadvantage (especially the combination of low parent education, family poverty, and some third dimension of disadvantage) (Crosnoe & Cooper, 2010, p. 26).

Guo and Harris (2000) found that the economic status of parents has had significant effects on mathematics achievement during early childhood, but its effects have not been shown to be as noteworthy as during later childhood. The reason is because there is a vital period in a child's life when development of cognitive skills is greatest and that is during the time before formal schooling when involvement by parents is generally the highest. In other words, the worst effects of poverty on children can be explained by a lack of early cognitive development within the home (Guo & Harris, 2000). Unfortunately, low-SES students receive less support in their home environment to

develop their mathematical skills than their middle and high-SES peers (Blevins-Knabe & Musun-Miller, 1999). Demir, Kilic, and Unal (2010) found that parents' educational background was also an important indicator for students' mathematics achievement, and noted that if parents had higher educational background, this could increase their children's later mathematics success. Starkey and Klein (2000) noted the gap between students' mathematics achievement associated with their SES background was not only explained by parents' financial resources, but it was mostly based on parents' educational background and exposure to mathematics. For example, although providing board game materials was cheap, and could be easily made at home, most Head Start children were not provided these activity games at home. While 80% of middle-income children reported that they played one or more board games activities at home, only 47% of Head Start children reported that they did (Ramani & Siegler, 2008). This demonstrates one of the reasons for the gap associated with SES background and why it is more likely due to parents' educational background rather than their financial resources.

Demir, Kilic, and Unal (2010) demonstrated that students whose parents were highly educated and exposed to mathematics before in their lives tended to show more success in mathematics than their peers whose parents were less educated and not being exposed to mathematics. The reason for this correlation is because highly educated parents knew the learning requirements and had the opportunity to provide the best educational environment for their children (Alomar, 2006).

> Exploring the contribution of these educational settings is important because interpreting SES effects as emanating exclusively from the family or the child means that policy and program intervention may focus too narrowly as they attempt to improve the educational outcomes of low-SES children (Aikens & Barbain, 2008, p. 236).

U.S. Department of Health and Human Services (2005) reported Head Start programs were not significantly impacting students' early mathematics development. Later, Clements and Sarama (2007) showed similar findings that students who attended Head Start demonstrated little gains in numbers and almost no gain in geometry. Therefore, research in mathematics education should specifically target programs like Head Start and reconsidered it in terms of its impact on children's early and later mathematics achievement, with more parental involvement being encouraged. Also, parent-child, teacher, and school communication need to be integrated into K-12 in various ways to reinforce students' mathematics development (Bicer, et al., 2010).

Parents-Child, Teacher, and School Communication

In order to decrease the gap in students' mathematics achievement, parents might be encouraged to participate in their children's education actively by attending school events, activities and mathematics workshops. Griffin, Case, and Siegler (1994) noted that parent's active participation in small group mathematical activities led to improvement in their children's numeracy skills. For instance, playing games at home such as Building Block and Big Math can significantly impact children's mathematical development (Clements & Lewis, 2009). Reading books at an early age and having students receive help from their parents or guardians with their school homework can also foster children's mathematical development (Padavick, 2009).

Educators and educational programs in K-12 should emphasize parents-teacher, parent-child, and parents-school communication to yield positive effects on students' mathematics development. Bicer et al. (2010) found that obtaining curricular information from schools and/or teachers enables parents to follow the progress of their children; thus they can help their children with problems related to their mathematics learning. For example, when parents understand and are aware of school resources, they can encourage their children to use these resources. This is an especially helpful practice for students who have fewer resources at home. Although some children may have enough resources at home, their parents may not know how to use these resources in effective manner; thus making parent-school communication important. This is because parents can be assisted by school counselors or teachers when they have curricular questions (Bicer, et al., 2010).

Parent-teacher communication is vital for parents to track their children mathematics learning processes from a professional education viewpoint. Bicer et al. (2010) noted that if parents met with their children's mathematics teacher in order to guide their children at home, those children could become more successful than students whose parents did not participate in parent-teachers conferences. Epstein (2005b) demonstrated that students whose parents joined mathematics training and informational workshops had children who demonstrated more success than student whose parents did not attend.

Parents-school or teacher communication might be difficult because of the number of hours parents spend at their jobs, with other children at home, to name a few. To overcome these difficulties, new and innovative ideas can be used to promote parents participation such as online-communication tools (Strayhorn, 2010) or social networking sites. Shirvani (2007) researched four Algebra classes in order to show the effects of parental communication on students' mathematics success, and found that students whose parents received a monitoring sheet about their

mathematics' performance outperformed students whose parents did not use the sheet. Hyde, Quest, Alibali, Knuth, and Romberg (2006) noted that parent and school communication was more important for students whose parents did not possess enough mathematical background than for students whose parents had a strong mathematical background. This might be because less-educated parents may not know how mathematics plays a crucial role in their child's later education lives, and then they may not transmit more positive feelings to their child about mathematics.

Research has revealed that families from low SES background did not communicate with their children's school and teacher as much as parents from high SES background did. However, clear reasons have not been identified as to why families from low SES backgrounds often do not participate in educational programs and activities, and what else can be done to increase their participation (Cross et al., 2009). It has been shown that teachers, schools, and educators cannot easily change parental involvement structures, but communication between parents-child, parents-teachers, and parents-school can change parents' attitudes and beliefs about mathematics (Yan & Lin, 2005). Parental expectation as one of the important parental involvement parameter can be shaped by parental communication. Epstein (1995a) noted that in order for children to be successful in mathematics parents needed to demonstrate high expectations for school achievement despite their socio-economic background.

Parental expectations and beliefs about their children mathematics achievement

Parents can increase the potential development of their children mathematical knowledge and skills by setting high expectations and providing stimulating environments (Cross et al., 2009). Because early education years have been found to be so vital for children's later mathematics achievement, children need to be supported by their parents in their social, emotional, and cognitive development in addition to instructional support in mathematics. What happens at student's homes is related to their mathematics intrinsic motivation in childhood and later improvement through high school (Gottfried, Gottfried, & Oliver, 2009).

Parents' behaviors are crucial for their children attitudes towards mathematics (Hyde, Quest, Alibali, Knuth, & Romberg, 2006), but the relationships between parents' academic reinforcement and student's mathematics achievement was not found a significant. However, a significant relationship was found between the parents' mathematical values and students' mathematics achievement (Hong, You, & Wu, 2010). If parents thought mathematics was important, they could transfer this importance to their children's mathematics success; thus they have more positive attitudes towards mathematics.

Much research has shown the relationship between parental beliefs and attitudes, including the expectations of parents, target orientations, and ability beliefs' children espouse (Friedel, Cortina, Turner, & Midgley, 2007). However, most parents thought that the mathematics skill of their children is less important than other skills of their children. Barbarin et al. (2008) demonstrated that parental time spent on literacy skills was rated at 50%, however, the time they spend on their children's numeracy skills was rated as only 3.5%. Cannon and Ginsburg (2007) also concluded similar findings as mothers thought learning literacy, and developing language skills were more important than learning mathematics. The survey done by these researchers showed that mothers spent much of their time developing their children's language usage, however, they devoted less time to working on mathematical skills with their children. However, to decrease the gap between Low-SES and High-SES background of students mathematics achievement, parents' role should be mentioned as follow:

> Parents need to become teachers within their homes. There are two key reasons behind this statement: (a) parents can influence their children by being their original teachers of intrinsic motivation, morals, and discipline; and (b) they can capitalize on the teachable moments that happen in abundance in the home! (Padavick, 2009, p. 97).

By providing more positive encouragement, parents can support their children's mathematics success. Canavagh (2009) reported that parents helping to improve their children's skills in mathematics leads to an increase in their children mathematics test scores. Children who received high levels of encouragement showed more persistence and effort when they faced difficult mathematical tasks (Hokoda & Fincham, 1995). Tocci and Ergelhard (1991) indicated that the higher levels of encouragement children received from their parents, the more positive the attitudes they displayed in their mathematics courses. In contrast, when the lower level of encouragement children received from their parents, the higher mathematical anxiety these children demonstrated. Almost all parents tried to encourage their children in mathematics, but they either did not know how to involve and/or they did not know why their involvement was important. Cavanagh (2007) showed that parents can make mathematics more interesting and joyful for their children by practicing real world informal mathematics that schools usually do not provide. Students whose parents were aware, knowledgeable, encouraging, and involved tended to gain higher academic achievement than students whose parents were not. Despite the differences between parents' backgrounds, a general view to be successful in mathematics was when parents showed high expectations for the school achievement of their children (Epstein, 1995a).

Purpose of the Statement

The present study's purpose was to examine how the socioeconomic background of parents, namely parents' income and parents' educational level, indirectly relates to children's mathematics achievement as mediated through parental expectations and parental communication.

METHOD

Participants

To conduct the present study, many relevant samples from previous studies were reviewed to find the best fit answer associated with the purposes of the study. After analyzing many data sets, one correlation matrix reported by Davis-Kean (2005) was selected because this matrix included all the variables which were previously selected for use in this study. In the present study, only 5 variables (see the correlation matrix in Table 1) associated with the present study were purposefully selected among 27 variables.

Table 1. Correlation Matrix

Variables	Parent's Education	Family Income	Parental Expectation	Parent-Child Communication	Mathematics Achievement
Parent's Education	1				
Family Income	.53	1			
Parental Expectation	.42	.34	1		
Parent-Child Communication	.17	.18	.24	1	
Mathematics Achievement	.38	.33	.44	.21	1

This correlation matrix was derived from a national, cross-sectional study of children, the 1997 Child Development Supplement of the Panel Study of Income Dynamics (PSID-CDS) data set were used. The data-set included families with children up to 12 years of age. In cases where there were more than 2 children at home, only one child from each family was randomly selected to avoid perfectly correlated data. The PSID data-set included interviews, home-observations, and students' reading and mathematics achievement scores. The preset study sample size was 868 because the correlation matrix reported by Davis-Kean (2005) reported only the sample of 868 students from the 1997 PSID data set. This sample includes 8-12 years old middle school students, and their gender was equally distributed with 435 females and 433 males. The ethnicity of participants were mainly European American (n= 423) and African American (n= 411), with the remaining (n= 34) from the other ethnic backgrounds.

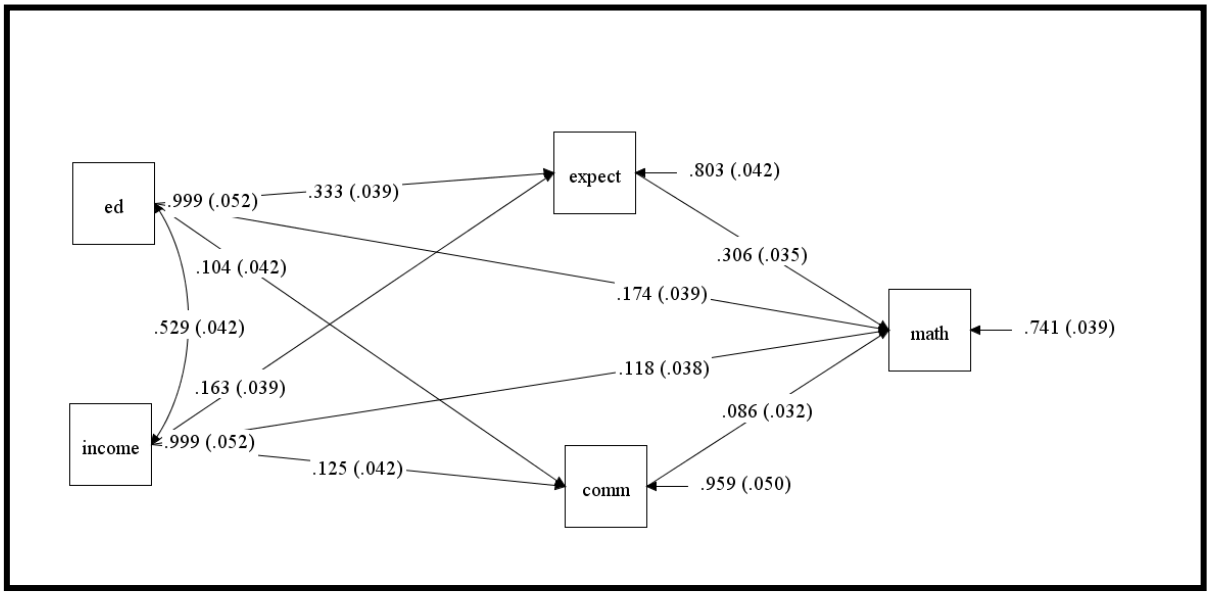
Measures and Analysis

In the present study parent's income, parents' education, parents' expectation, and parents-child communication were selected as predictor variables, and students' mathematics achievement score was the outcome variable. To test the hypotheses that parent income and education indirectly influenced children's mathematics achievement through parental expectation and communication, structural equation modeling (SEM) in M-plus was employed to estimate the fit of the hypothesized model (see Figure 1). All fit indices in M-plus were taken into account to determine whether or not the hypothesized model fit the given data.

RESULTS

The results from the SEM analysis revealed that parent's income and parent's education were related to students' mathematics achievement indirectly through parental expectations and parental communication. The goodness-of-fit indices for the hypothesized model were: chi-square (1= df) = 23.093, CFI = 0.95 and SRMR= 0.04 indicating that the hypothesized model (see in Figure 1) fits well to the data, and the explained variance of children's mathematics achievement (R^2 = .25). Without parental expectations and parental communication, the explained portion of children's mathematics achievement by parent's education and parent's income was (R^2 = .16).

Figure 1. Standardized parameter values of the model.



According to the hypothesized model, all paths other than the two paths (one from parental communication to students' mathematics achievement, and the other from income to parental communication) drawn were statistically significant, and each path was positively estimated as shown in Figure 1. In the hypothesized model, the direct path through parent's educational level to students' mathematics achievement (β = .17, p < .005), the direct path through parent's income to students mathematics achievement (β = .11, p < .005), and all other indirect paths were non zero; thus suggesting that parental expectation and parent-child communication have mediation effects on students' mathematics achievement, but this mediation effect was partial. In other words, students' mathematics achievement was not fully mediated by the indirect path of parental expectation and parental communication. The mediation effects of parental expectation on parental education level to explain students' mathematics achievement were (.333x .306 = .101) about 10 %, and had the largest mediation effects on mathematics achievement compared to other mediation effects in the hypothesized model. Therefore, the present study suggested that there might be other mediation effects which were not taken into account in the hypothesized model. Table 2 through 5 shows the estimation, significance, and relationships to variables of each path in the hypothesized model.

Table 2. Standardized Parameter Estimates, p Values, and Relationships of Variables

Variables		Estimates	p	Relationship
Mathematics on	Parental Communication	.08	>.005	Positive
	Parental Expectation	.30	< .005	Positive
	Income	.11	< .005	Positive
	Parent's Education Level	.17	<.005	Positive

Table 3. Standardized Parameter Estimates, p Values, and Relationships of Variables

Variables		Estimates	p	Relationship
Communication on	Income	.12	>.005	Positive
	Parent's Education Level	.10	<.005	Positive

Table 4. Standardized Parameter Estimates, p Values, and Relationships of Variables

Variables		Estimates	p	Relationship
Income with	Parent's Education Level	.53	<.005	Positive

Table 5. Standardized Parameter Estimates, p Values, and Relationships of Variables

Variables		Estimates	p	Relationship
Expect on	Income	.16	< .005	Positive
	Parent's Education Level	.33	<.005	Positive

DISCUSSION

The present study examined the effects of parental-expectation and parent-child communication as mediator variables on parents' educational level and parents' income to explain students' mathematics achievement. The hypothesized model proposed that parents' education level and parents' income were indirectly related to students' mathematics achievement through the parental expectation and parent-child communication. In the model, parental expectation has the largest mediation effects on parents' education level to explain students' mathematics achievement. This suggests that parents with higher educational backgrounds set a higher success expectation from school to their children. However, the mediation effects of parental expectation are small on parents' income to explain students' mathematics achievement. The reasons why parental expectation has larger mediation effects on parents' education level rather than parents' income might be because: 1) highly educated parents are more likely to be believers of mathematics importance on their children lives; thus they transfer their positive feelings and attitudes to their children (Hong, You, & Wu, 2010). Once students are exposed to positive mathematics feelings and attitudes, their intrinsic motivation towards mathematics can increase (Gottfried, Gottfried, & Oliver, 2009) and they want to be more successful in mathematics, 2) students whose parents were highly educated and exposed to mathematics before in their lives tended to show more success in mathematics than their peers whose parents were less educated and not exposed to mathematics (Demir, Kilic, & Unal, 2010). Therefore, because highly educated parents knew the learning requirements and had opportunities to provide the best education environment for their children (Alomar, 2006), their children were exposed earlier to mathematics in the most effective home educational environment.

In the hypothesize model, there are two non-statistically significant paths; one is from parents' income to parent-child communication, and the other is from parent-child communication to students' mathematics achievement. This is surprising because the literature revealed parental communication is one of the important parental factor on children' mathematics achievement. However, the reason why these two paths are not significant might be due to the present study's limitation that parent-child communication was selected as only one variable, but there are various parental communication namely parent-child, parent-school, and parent-teacher. Further research needs to investigate all three parental communication dimensions to determine the role of parental communication on students' mathematics achievement.

In summary, parental expectation and parental communication are two important variables that can increase students' mathematics achievement. Regardless of parental background related to SES and education level, the gap between high and low SES background students' mathematics achievement can be reduced by increasing parental expectations and parental communication. Once parental communication is establish, parental expectation will more than likely happens by itself. This is because once parents communicate with their children and their children's teachers; they may become more knowledgeable about their children needs.

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