

---

## The Relationship between Parental Involvement and Math Achievement Mediated by Math Self-Efficacy and Math Interest: A Comparison between High- and Low-Achievers

Hyo Jin Lim<sup>1</sup>, Sun Ah Lim<sup>2\*</sup>, Kyung Sun Chung<sup>3</sup>

<sup>1</sup>Seoul National University of Education, South Korea

<sup>2</sup>Jeonbuk National University, South Korea

<sup>3</sup>Pennsylvania State University, USA

\*Corresponding author: Department of Education, Jeonbuk National University, 567 Baekje-daero, Deokjin-gu, Jeonju-si, Jeollabuk-do, 54896, South Korea. Email: sunahlim@jbnu.ac.kr

---

### ABSTRACT

In this study, we examined how math self-efficacy and math interest mediated the relationship between parental involvement and math achievement using the Programme for International Student Assessment (PISA) 2012. We further investigated whether the relationship differed according to the students' math achievement. Results of the structural equation modeling showed that parental involvement predicted math self-efficacy and math interest directly and math achievement indirectly. Parental support positively predicted math self-efficacy only among low achievers, while parental participation positively predicted math self-efficacy only among high achievers. Parental expectation positively predicted math interest in both groups, although the relationship was significantly stronger among high achievers. Finally, math interest significantly and negatively predicted achievement only among low achievers.

### Keywords

Parental Involvement; Math Self-efficacy; Math Interest; Math Achievement; PISA 2012

---

### Introduction

Students with better academic performance in middle and high school are more likely to go on to postsecondary education and above. Since academic success is also associated with a better career path, higher socio-economic status, and greater personal well-being, it is crucial for educators and professionals to find ways of improving student academic achievement.

Motivation is often assumed to contribute to academic achievement as it helps students direct, maintain, and persist in their learning. Self-efficacy is an important motivational indicator in learning and academic performance. The higher self-efficacy students have, the more likely they are to choose more activities, set more challenging goals, and put more effort into their activities. Besides self-efficacy, interest is another factor of positive outcomes in general and particularly in mathematics (Singh, Granville, & Dika, 2002). Interest helps individuals actively engage in their learning process by using their knowledge and skills more effectively. When students are

interested in learning, they devote more attention to their tasks and better utilize their resources for learning (Hidi & Renninger, 2002). Evidence of positive associations has been consistently found between interest and academic performance (Allen & Robbins, 2010; Singh et al., 2002).

Students' academic success can be enhanced by significant others such as parents and teachers. Parents can promote students' academic achievement by enhancing their motivation (Patrick, Ryan, & Kaplan, 2007). Parental involvement is known to be positively related to academic performance throughout middle and high school (Hill et al., 2004). However, some researchers (Bronstein, Ginsberg, & Herrera, 2005) reported no relationship between parental involvement and achievement. A possible explanation for this discrepancy is that this association can be moderated by other confounding variables. For example, students with higher motivation may recognize the positive role of parental involvement in their learning, while students with lower motivation may perceive parental involvement as pressure and stress, which

could have a negative influence on their achievement (Kim & Kim, 2013). Silinskas and Kikas (2019) found that students with low self-concept in math tended to perceive increased parental control, which in turn led to a lower math performance. While most researchers agree that parental involvement positively predicts the students' academic achievement, there is little research on whether this association differs based on their achievement level.

## Literature Review

### Types of parental involvement

Parental involvement can be defined as “the parents' interactions with schools and with their children to promote academic success” (Hill et al., 2004, p. 1491). School contact and participation in school-based activities are considered major sources of parental involvement (Fan & Chen, 2001). Epstein and Sanders (2002) conceptualized parental involvement as a school-based involvement (e.g. volunteering at school, communication with teachers, participation in the school government) and a home-based involvement (e.g. supporting children's academic activities at home, participating in school-based support such as parent training programs and school/community organizations). We therefore consider parental involvement as a multi-dimensional concept reflecting parental attitudes and activities in the home and school aimed at facilitating children's academic adjustment.

### The role of parental involvement

Studies has shown that there are direct and indirect relationships between parental involvement and student motivation and achievement. Regarding the association between parental involvement and self-efficacy, Schunk and Pajares (2009) indicated that the development of self-efficacy is influenced by familial, social, and cultural factors. Fan and Williams (2010) illustrated the importance of parental involvement in terms of school participation (e.g. participating in extracurricular activities with their child, parent-school communication, school-initiated

contact with parents), parental aspiration (e.g. parental expectations of their children's highest degree in education), and family rules (e.g. family rules for doing homework, doing household chores, watching TV) and its positive relation with student self-efficacy. Specifically, they found that parental aspirations for children's postsecondary education and school-initiated contact with parents significantly and positively predicted children's self-efficacy.

Parental involvement is also related to interest. Ginsburg and Bronstein (1993) reported that parental help with homework and reaction to academic grades was one of the sources of children's intrinsic motivation and the parents' delivery of positive and encouraging feedback helped improve the children's preference for challenging tasks, curiosity, and interest in learning. Ames, de Stefano, Watkins, and Sheldon (1995) noticed the importance of providing parents with information about classroom learning activities in children's academic interest. They found that the students' interest increased when parents had opportunities to communicate with teachers and expressed their educational concerns to their children.

Although there is evidence that parental involvement has a positive impact (Sénéchal & LeFevre, 2002), Fan and Chen (2001) demonstrated that various types of parental involvement have differential effects on academic achievement. Hill and Tyson (2009) conducted a meta-analysis on parental involvement and middle school students' academic achievement. While they found a positive correlation between general parental involvement and achievement, the type of parental involvement moderated this correlation. For example, helping with their children's homework was negatively associated with achievement, whereas other home-based involvement subtypes (e.g. academic socialization such as providing educationally enriching activities at home or making books and other materials available) were positively related to achievement.

Considering the familial influence on students' learning and motivation, family norms might play a role in facilitating children's positive cognitive and affective development in school. Family

norms include family rules, educational expectations, and the quality of parent–child relationship (Yan & Lin, 2005). It is well known that children’s general and specific self-concepts of their abilities are influenced by their perceptions of socializers’ beliefs, expectations, and attitudes (Eccles & Wigfield, 2002). Jodl, Michael, Malanchuk, Eccles, and Sameroff (2001) found that parental educational expectations could change their children’s perceptions of competence, self-efficacy beliefs, and academic achievement. Similar to Jodl et al., Benner and Mistry (2007) found that mothers’ educational expectations were positively associated with adolescents’ concepts of expectations for their abilities, which in turn predicted academic achievement (as measured by a standardized achievement test and mothers’ ratings of their children’s academic performance).

### **Positive associations among self-efficacy, interest, and achievement**

Bandura (1997) has conceptualized self-efficacy as the individual’s belief in the ability to attain their goals successfully. Students with high academic self-efficacy are more likely to choose more challenging tasks and attempt to master and regulate their own learning. Pajares and Miller (1995) cautioned that a self-efficacy assessment should capture a more specific topic or task in a certain domain. Thus, the domain-specific self-efficacy in mathematics is defined by Hackett and Betz (1989) as “a situational or problem-solving assessment of an individual’s confidence in her or his ability to successfully perform or accomplish a particular task or problem” (p. 262). Kung (2009) also proposed that math self-efficacy is composed of four elements such as insistency, confidence, subject-specific self-efficacy and problem-specific self-efficacy. Math self-efficacy was positively connected to problem-solving math tasks for undergraduate students (Parajes & Miller, 1995) and mediated parental involvement and math score for middle school students. Lee and Stankov (2013) also reported that math self-efficacy was the strongest predictors among the non-cognitive variables relating to math achievement. This was

true even after controlling for the shared variance of other motivational and attitudinal variables.

Research on expectancy-value theory revealed a strong relationship between interest and expectations about one’s ability. Wigfield et al. (1997) found that self-perceived ability and subjective task value (i.e. interest, utility, and attainment value) are closely related. Ferla, Valcke and Cai (2009) demonstrated that math self-efficacy positively predicted math interest. Math interest is interest in and enjoyment of mathematics (OECD, 2013) and literature suggests that it has an effect on engagement in math class, time-on-task, performance and career-choice in math. In a meta-analysis, Schiefele, Krapp, and Winteler (1992) found that interest influences academic achievement in numerous subjects, including math, science, social science, foreign languages, and literature. Despite the positive correlation between interest and achievement ( $r=.30$ ), some researchers (Lopez, Lent, Brown & Gore, 1997) have found that achievement level related to self-related beliefs (e.g. perceived competence) could moderate the relationship between interest and achievement.

### **Current study**

We examined Korean adolescents’ math achievement using the Programme for International Student Assessment (PISA) 2012, testing a structural model of the relationships between parental involvement, math self-efficacy, math interest, and math achievement. We first hypothesized that parental involvement (i.e. participation in school, support in schoolwork, expectations about their children’s math career) would predict math self-efficacy and math interest, which in turn would predict math achievement. We also hypothesized that the various types of parental involvement would differently predict math self-efficacy and math interest.

Second, we hypothesized that the structural relationship in the research model would significantly differ according to a students’ achievement level. Therefore, we examined whether high- and low-achieving students showed

significantly distinct patterns of associations among variables of interest.

### Method

#### Data

The data of the present study are from the PISA 2012, which is an internationally standardized assessment developed by the OECD (OECD & UNESCO-UIS, 2003). The PISA 2012 measured the academic achievement of 15-year-olds in reading, mathematics, and science, with an emphasis on mathematics. The PISA uses a two-stage stratified sampling design. Thus, a representative sample of schools is drawn, from which students are randomly selected. In the current study, data collected in South Korea were analyzed. Parents (mother or father) or others of selected students are asked to complete the survey. Among 5,018 students, mothers ( $n=3,669$ ) and fathers ( $n=1,089$ ) and others ( $n=51$ ) responded; the number of students whose mother and father responded is 150 and the number of students whose mother and others responded is 3. The remaining 56 cases were classified as missing.

After excluding cases without responses to any of the main variables, the final sample size was 4,973. The sample comprised of 2,655 boys (53.39%) and 2,318 girls (46.61%), with a mean age of 15.71 ( $SD=0.29$ ). Students with math scores lower than the mean of the Korean sample ( $M=553.75$ ,  $SD=96.43$ ) were classified as low achievers ( $n=2,401$ ) and those with scores equal to or above the mean were classified as high achievers ( $n=2,572$ ).

#### Measures

The predictor variable, parental involvement, was assessed in terms of parental participation, support, and expectations. Parental participation was assessed with six items indicating whether parents participated in their child's school by selecting either 1 (*yes*) or 2 (*no*). These responses were then recoded as 0 (*no*) and 1 (*yes*). Parental support was measured with four items reflecting the parents' support at home (e.g. help with their child's schoolwork relating to math) assessed on a scale from 1 (*never or hardly ever*) to 5 (*every day or almost every day*). Parental expectations were

evaluated with two items measuring whether parents expect their children to major in math or choose a math-related career. Parents responded to each item with either 1 (*yes*) or 2 (*no*), and these responses were recoded as 0 (*no*) and 1 (*yes*). The Cronbach's alpha reliability coefficients were .62 for parental participation, .81 for parental support, and .78 for parental expectations.

The mediating variables used in the present study were math self-efficacy and math interest. Math self-efficacy is defined here as the degree to which students believe in their own ability to solve or understand math problems (OECD, 2013). The math self-efficacy in this study uses task-specific questions that assess a student's confidence in performing various math problems. Thus, the domain-specificity of this measure might allow students to more accurately assess their math self-efficacy (Pietsch, Walker, & Chapman, 2003). The measure asks students to rate the ease with which they believe they could solve eight specific math problems, which solve from a simple algebraic equation (e.g.  $3x + 5 = 17$ ) to a complex model building question (e.g. calculating the petrol consumption rate of a car) (OECD, 2005, p. 292). All eight items were scored on a four-point Likert scale ranging from 1 (*very confident*) to 4 (*little confident*); scores were recoded so that higher scores indicated higher self-efficacy. The Cronbach's alpha was .89.

The second mediating variable, math interest, measured the degree to which students enjoy reading about math, look forward to math lessons, and are interested in learning math. The four items in this scale were rated on a four-point Likert scale ranging from 1 (*strongly agree*) to 4 (*strongly disagree*), and then recoded so that higher scores indicated greater interest. The Cronbach's alpha was .91.

Math achievement was set as an outcome variable. The scaled achievement scores included five plausible values for each student, generated by randomly drawing from an estimated ability distribution of students with similar item response patterns and backgrounds (OECD, 2013) using item response theory. These plausible values are more appropriate for estimating population parameters than fixed values (Wu, 2005) because they are randomly drawn from the posterior

distribution of a students’ ability (OECD, 2013). All five plausible values must be used simultaneously to obtain population parameter estimates. Accordingly, all analyses involving achievement had to be repeated for each of the five achievement estimates. As we also had to impute missing data five times, we jointly handled

both issues by fitting all models five times and combining the parameter estimates (Rubin, 1987). As the math achievement variance was much greater than were the variances in the other variables in these models, we use the natural log of math achievement to stabilize the variance (Weisberg, 2005).

**Table 1.** Descriptive Statistics of Research Variables

Items	Mean	SD	Min	Max
<i>Parent participation</i>				
1. Activities - Volunteer maintenance	0.18	0.39	0	1
2. Activities - Volunteer clubs	0.12	0.33	0	1
3. Activities - Volunteer library	0.05	0.21	0	1
4. Activities - Assist teacher	0.08	0.27	0	1
5. Activities - Guest speaker	0.01	0.11	0	1
6. Activities - School government	0.11	0.31	0	1
<i>Parent support</i>				
1. With Child - Homework help	1.79	1.12	1	5
2. With Child - Performance math	2.83	1.19	1	5
3. With Child - Math materials	1.93	1.12	1	5
4. With Child - Applying math	2.07	1.13	1	5
<i>Parental expectations</i>				
1. Math Career - Child expectation	0.45	0.50	0	1
2. Math Career - Child study expectation	0.41	0.49	0	1
<i>Math self-efficacy</i>				
1. Math Self-Efficacy - Using a train timetable	2.79	0.83	1	4
2. Math Self-Efficacy - Calculating TV discount	2.91	0.89	1	4
3. Math Self-Efficacy - Calculating square metres of tiles	2.70	0.91	1	4
4. Math Self-Efficacy - Understanding graphs in newspapers	2.91	0.82	1	4
5. Math Self-Efficacy - Solving equation 1	3.24	0.87	1	4
6. Math Self-Efficacy - Distance to scale	2.39	0.92	1	4
7. Math Self-Efficacy - Solving equation 2	3.01	0.94	1	4
8. Math Self-Efficacy - Calculate petrol consumption rate	2.25	0.84	1	4
<i>Math interest</i>				
1. Math Interest - Enjoy reading about math	2.07	0.82	1	4
2. Math Interest – Look forward to lessons	1.95	0.79	1	4
3. Math Interest – Enjoy math	2.12	0.89	1	4
4. Math Interest – Interested	2.39	0.91	1	4
<i>Natural log of math achievement</i>				
1. Plausible value 1 in mathematics	6.30	0.19	4.73	6.79
2. Plausible value 2 in mathematics	6.30	0.19	5.21	6.81
3. Plausible value 3 in mathematics	6.30	0.19	5.14	6.77
4. Plausible value 4 in mathematics	6.30	0.19	5.07	6.79
5. Plausible value 5 in mathematics	6.30	0.19	5.18	6.79

## Analysis

The analyses in this study were performed in two stages. In the first stage, structural equation modeling was used to verify the hypothesized model. First, we evaluated the fit of the measurement model through a confirmatory factor analysis, after which we tested the structural model. Parental participation, parental support, parental expectation, math interest, and math-self-efficacy were conceptualized as latent variables, and their individual items as observed variables. Secondly, we conducted a multiple-group analysis to explore the moderating effect of achievement level on the relationship of variables. We tested whether the same model could be acceptable across all groups and then examined if there were significant differences in path parameters between high- and low-achieving groups (Heck & Thomas, 2000; Steenkamp & Baumgartner, 1998).

The model fit was assessed in terms of the chi-square fitness test, comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). Values lower than .08 for the RMSEA and SRMR and values close to .90 for the CFI and TLI indicate acceptable model fitness (Bentler, 1990). All analyses were conducted using the Mplus program (Muthén & Muthén, 2012).

As with most survey data, the PISA datasets has missing values. However, as the PISA provides extensive information on students and parents, it allows us to control these missing variables and assume the data are missing at random (MAR). Accordingly, we employed a multiple imputation technique using the ice option of the Stata program to retain the largest possible sample size. Before merging the student and parent data, we applied multiple imputations separately, and then merged these two imputed datasets. Subsequently, we generated five datasets and averaged the coefficients and standard errors from the analyses across these five datasets using the Mplus function. To correct for design effects, we used the final student weight variable (W\_FSTUWT), following the PISA's recommendation (OECD, 2003). Additionally, given the nested nature of the PISA data (i.e., students are nested within sampled

schools), we used both the CLUSTER option and the TYPE=COMPLEX option of the Mplus program, which employ sandwich estimators to calculate standard errors (White, 1982) in order to adjust for the inflated standard errors resulting from the violation of the independent errors assumption.

## Results

### Preliminary analysis

A preliminary analysis was conducted to provide descriptive statistics and to examine whether the data met the assumptions for structural equation modeling. According to the guidelines of severe non-normality (i.e., skewness > 3; kurtosis > 10) proposed by Curran, West, and Finch (1996), the normality assumption of research variables was met; that is, the skewness values were less than 3 and the kurtosis values were less than 10. Table 1 and Table 2 present the descriptive statistics and bivariate correlations of all variables. Table 2 also includes mean group differences, displaying that the mean scores for all variables of high-achieving students are significantly higher than those of low-achieving ones.

### Measurement model

The fit indices for the measurement model were  $\chi^2(242)=5430.825$ , CFI=.926, TLI=.913, RMSEA=.065, and SRMR=.045, indicating acceptable fit (except for the chi-square value, which is sensitive to sample size). Because the Mplus program estimated parameters by averaging across the five datasets of plausible values of math achievement, the program could not provide a 90% confidence interval for the RMSEA. The standardized factor loadings in the measurement model were .300 to .594 for parental participation, .662 to .798 for parental support, .803 for parental expectations, .639 to .813 for math self-efficacy, and .796 to .908 for math interest. After testing the measurement model, we analysed the fit of the structural model for all groups and the model showed good fit indices ( $\chi^2[264]=5575.053$ , CFI =.931, TLI=.919, RMSEA=.064, SRMR=.040)

### Multi-group structural equation modeling

To examine group differences in the model paths, we employed a multiple group structural equation modeling. First, the measurement model for latent

variables must operate equivalently across different groups, thereby ensuring that the paths are meaningfully comparable across groups (i.e. metric invariance). Thus, we constrained the loadings in the measurement model to be equal across all groups. This model with invariance constraints had a good fit to the data ( $\chi^2[571] = 6363.974$ , CFI = .912, TLI = .908, RMSEA = .064, SRMR = .068).

After assuming the same model is acceptable for both groups, we investigated a structural relationship among variables of interest where Table 3 and 4 present the path coefficients of research model. We observed significant group differences in the direct effects of two dimensions of parental involvement (i.e., participation and support) on math self-efficacy. Participation significantly predicted math self-efficacy only among high achievers ( $\beta = .081$ ,  $p < .05$ ) while support only significantly predicted math self-efficacy among low achievers ( $\beta = .080$ ,  $p < .05$ ). The path from parental expectations to math interest was significant and positive for both groups, although it was still stronger among high

achievers ( $\beta = .086$ ,  $p < .05$  for low achievers,  $\beta = .212$ ,  $p < .001$  for high achievers); this suggests that higher achievement might increase the positive effect of parental expectations. Finally, math interest negatively and significantly predicted math achievement among low achievers ( $\beta = -.008$ ,  $p < .05$ ), but not among high achievers ( $\beta = .002$ , *ns*).

### Discussions

This study examined how different types of parental involvement (i.e. participation, support, and expectation) predicted math achievement, and whether the relationship was mediated by math self-efficacy and math interest using a nationally representative dataset. We found parental involvement exerted positive impacts on self-efficacy and interest. Our study demonstrates that parental involvement affected math achievement via math self-efficacy and math interest; nonetheless the prediction of parental involvement was different according to the student achievement level.

**Table 2.** Descriptive Statistics and Bivariate Correlations among Low- and High-Achievers

		Participation	Support	Expectation	Efficacy	Interest	Achievement
Participation		-	.23***	.10***	.13***	.10*	.08***
Support		.21***	-	.14***	.12***	.13***	.04
Expectation		.04	.15***	-	.22***	.33***	.23***
Efficacy		.04	.14***	.18***	-	.46***	.53***
Interest		.00	.13***	.21***	.52***	-	.33***
Achievement		-.05	.01	.10***	.37***	.19***	-
M	High	0.10 <sup>a</sup>	2.19 <sup>a</sup>	0.52 <sup>a</sup>	3.14 <sup>a</sup>	2.40 <sup>a</sup>	630.99 <sup>a</sup>
	Low	0.08	2.11	0.34	2.42	1.86	475.88
SD	High	0.17	0.89	0.45	0.54	0.72	53.19
	Low	0.16	0.93	0.43	0.57	0.69	59.66
Skewness	High	2.05	0.78	-0.08	-0.08	0.02	0.74
	Low	2.53	0.69	0.66	-0.32	0.48	-1.01
Kurtosis	High	4.60	0.35	-1.76	-0.48	-0.35	0.18
	Low	7.16	-0.21	-1.30	0.66	-0.12	0.89

Note. \*  $p < .05$ , \*\*\*  $p < .001$

Correlations for low-achievers are below the diagonal, correlations for high-achievers are above the diagonal.

<sup>a</sup> Two groups difference is significant at  $p < .05$ .

**Table 3.** Standardized and Unstandardized Estimates of the Model across Low- and High- Achievers

		Low achievers (n=2,401)			High achievers (n=2,572)		
		B	S.E	$\beta$	B	S.E	$\beta$
Participation	→ Efficacy	.007	.047	.007	.079	.039	.081*
Support	→ Efficacy	.078	.034	.080*	.054	.030	.055
Expectation	→ Efficacy	.149	.032	.152***	.173	.035	.177***
Participation	→ Interest	-.028	.028	-.034	-.038	.031	-.047
Support	→ Interest	.025	.023	.030	.023	.031	.028
Expectation	→ Interest	.071	.036	.086*	.170	.023	.212***
Efficacy	→ Interest	.544	.022	.647***	.540	.026	.656***
Efficacy	→ Achievement	.421	.030	.061***	.421	.031	.038***
Interest	→ Achievement	-.064	.029	-.008*	.033	.033	.002

Note. \*  $p < .05$ , \*\*\*  $p < .001$

**Table 4.** Direct and Indirect Effects in the Model across Low and High Achievers

		Low achievers (n=2,401)			High achievers (n=2,572)		
		Direct	Indirect	Total	Direct	Indirect	Total
Participation	→ Efficacy	.007		.007	.081		.081
Support	→ Efficacy	.080		.080	.055		.055
Expectation	→ Efficacy	.152		.152	.177		.177
Participation	→ Interest	-.034	.005	-.029	-.047	.053	.006
Support	→ Interest	.030	.050	.080	.028	.036	.064
Expectation	→ Interest	.086	.098	.184	.212	.116	.379
Participation	→ Achievement		.000	.000		.003	.003
Support	→ Achievement		.005	.005		.002	.002
Expectation	→ Achievement		.009	.009		.007	.007
Efficacy	→ Interest	.647		.647	.656		.656
Efficacy	→ Achievement	.061	-.005	.056	.038	.001	.039
Interest	→ Achievement	-.008		-.008	.002		.002

### Differential predictability of types of parental involvement

Parental involvement is considered a necessary condition for students to achieve good educational outcomes (Castro et al., 2015). Our research also found that parental involvement significantly raised math self-efficacy, math interest, and math performance. Specifically, parental expectations positively predicted students' math interest directly and their math achievement indirectly in high and low groups of achievers. However, parental participation and support did show different patterns according to students'

achievement level. Wilder's (2014) synthesis of research on parental involvement and academic achievement demonstrated that the association between two variables was strongest when involvement was defined as parental expectations. The findings of the current study may be due to the fact that children tend to have similar attitudes and beliefs as their parents, and their higher expectations about a specific subject (e.g. mathematics) might cause them to put more effort in that area.

This result also supports the assumptions of interest theories (Krapp, 2002; Ryan & Deci, 2000), proposing that students who have

internalized the values of a particular subject are more likely to develop a much deeper level of interest in it. This interpretation explains the stronger effect of parental expectation on children's math interest in the high-achieving student; that is, students whose parents expect them to enter a math-related career may obtain a higher level of achievement in math. Parents of low-achieving students, however, may be less likely to expect their children to have a math-related career.

### **Achievement level as a significant moderator**

We found differences in the pattern of associations between high- and low-achieving students, clearly showing that achievement level moderates the effect of parental support on math self-efficacy. In particular, parental support significantly and positively predicted math self-efficacy only among low-achieving students. While some studies have reported that parental homework assistance negatively predicts academic ability (e.g. Driessen, Smit, & Slegers, 2005; Schumow & Miller, 2001) and self-regulation (Bembenutty, 2006), we found that parental academic support at home (including homework assistance) had a positive impact, particularly among low-achieving students. This finding shows that the level of assistance might differ by children's academic needs and requests to receive assistance from parents (Wilder, 2014). The findings in this study also parallel the idea that the level of children's academic performance determines the degree to which parents' help with schoolwork (Hoover-Dempsey & Sandler, 1995; Maccoby, 1992). Indeed, Silinskas, Niemi, Lerkkanen, and Nurmi (2013) suggest that poor academic performance among children can cause parents to engage in more frequent homework assistance. Similarly, Shumow and Miller (2001) postulate that the degree to which children show incompetent or problematic behaviours in the home might push parents to be more involved in their schooling.

We also found that the effects of parental participation in school activities (e.g. volunteering, assisting teachers) differed by achievement level, with parental participation

influencing math self-efficacy only among high achievers. This result might be explained by Gutman and McLoyd's (2000) where they posited that the parents of high achievers not only were more involved but had different reasons for their school involvement than did the parents of low achievers. For example, parents of high achievers used more specific strategies to help their children with schoolwork and had more informative conversations with children when compared to parents of low achievers.

Taking our findings together it is important to facilitate self-efficacy through parental involvement, using the information on a student's achievement level. On one hand, parental academic support had a strong positive effect only for low-achieving students. As a result, it can be effective for students with some difficulties in schoolwork than for students without such difficulties. On the other hand, parental participation in school activities strongly predicted increased self-efficacy in high-achieving students only. Thus, parental participation can be of greater benefit to students who are doing well in school.

Finally, the association between interest and achievement differed by achievement level. The path from math interest to math achievement was negative among low achievers and was not significant among high achievers with very small effects in magnitude. Grigg, Perera, McIveen and Svetleff (2018) pointed out the mixed effect of interest on achievement. Despite the empirical findings on the positive link of the two (Jansen, Lüdke, & Schroeders, 2016; Schiefele et al., 1992), interest and achievement often showed a null relation (Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005) or even a negative one (Pinxten, Marsh, De Fraine, Van Den Noortgate, & Van Damme, 2014). A possible explanation for this result is that interest in itself has a shared variation with self-efficacy in explaining achievement. It has been noted that when controlling for self-efficacy, the remaining influence of interest only represents the expansion of future intention to engage in a certain domain. It may be possible that this mechanism negatively affects the immediate outcome (Grigg et al., 2018). In their longitudinal study, Ganley and Lubienski (2016) found that math interest did not predict later math

score while math self-confidence did predict subsequent math interest and math score.

This finding partially aligns with previous evidence showing that a strong positive association between interest and self-concept (Marsh et al., 2005). Given that self-concept, like self-efficacy, is a strong and positive predictor of achievement, the association between interest and achievement is less salient for low-achieving students than for high-achieving ones. However, the results of the current study must be evaluated in terms of the directionality of the relationship. Our findings did not support the position that a student's achievement level can simultaneously lead to a parents' higher or lower involvement. Bidirectional effects of variables on math achievement should be further examined based on the relational dynamics between parents and children.

### Limitations and Future Studies

First, although the PISA 2012 enables international comparison among parent- and student-related variables, our results might not be the same across different cultures. Future research should conduct cross-cultural studies to test whether the relationships found in this study are generalizable to other educational contexts. Second, although self-efficacy and interest are the key to successful academic achievement, we omitted other critical factors that could influence math performance due to the limited variables in the PISA database. Further research should be conducted regarding the impact of various teacher and classroom characteristics on math achievement. Third, the cross-sectional nature of the dataset allowed us to conduct only correlational analyses. As this study did not explore the causal links, longitudinal or experimental designs should be employed in future research.

### Acknowledgement

This work was supported by the 2021 Research Fund of Seoul National University of Education.

### References

- [1] Allen, J., & Robbins, S. (2010). Effects of interest–major congruence, motivation,

and academic performance on timely degree attainment. *Journal of Counseling Psychology*, 57(1), 23–35.

- [2] Ames, C., de Stefano, L., Watkins, T., & Sheldon, S. (1995). *Teachers' school-to-home communications and parent involvement: The role of parent perceptions and beliefs* (Report no. 28). East Lansing, MI: Center on Families, Communities, Schools, and Children's Learning, Michigan State University.
- [3] Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.
- [4] Bembenuty, H. (2006). Parental involvement, homework, and self-regulation. *Academic Exchange Quarterly*, 10(4), 18–23.
- [5] Benner, A., & Mistry, R. S. (2007). Congruence of mother and teacher educational expectations and low-income youth's academic competence. *Journal of Educational Psychology*, 99(1), 140–153.
- [6] Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin*, 107(2), 238–246.
- [7] Bronstein, P., Ginsburg, G. S., & Herrera, I. S. (2005). Parental predictors of motivational orientation in early adolescence: A longitudinal study. *Journal of Youth and Adolescence*, 34(6), 559–575.
- [8] Castro, M., Expósito-Casas, E., López-Martín, E., Lizasoain, L., Navarro-Asencio, E., & Gaviria, J. L. (2015). Parental involvement on student academic achievement: A meta-analysis. *Educational Research Review*, 14, 33–46.
- [9] Curran, P. J., West, S. G., & Finch, J. F. (1996). The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. *Psychological Methods*, 1(1), 16–29.
- [10] Driessen, G., Smit, F., & Sleegers, P. (2005). Parental involvement and educational achievement. *British Educational Research Journal*, 31(4), 509–532.
- [11] Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals.

- Annual Review of Psychology*, 53(1), 109–132.
- [12] Epstein, J. S., & Sanders, M. G. (2002). Family, school, and community partnership. In M. Bornstein (Ed.), *Handbook of parenting: Vol. 5. Practical issues in parenting* (pp. 407–432). Mahwah, NJ: Erlbaum.
- [13] Fan, X., & Chen, M. (2001). Parental involvement and students' academic achievement: A meta-analysis. *Educational Psychology Review*, 13(1), 1–22.
- [14] Fan, W., & Williams, C. M. (2010). The effects of parental involvement on students' academic self-efficacy, engagement and intrinsic motivation. *Educational Psychology*, 30(1), 53–74.
- [15] Ferla, J., Valcke, M., & Cai, Y. (2009). Academic self-efficacy and academic self-concept: Reconsidering structural relationships. *Learning and Individual Differences*, 19, 499–505.
- [16] Ganley, C. M., & Lubienski, S. T. (2016). Mathematics confidence, interest, and performance: Examining gender patterns and reciprocal relations. *Learning and Individual Differences*, 47, 182-193.
- [17] Ginsburg, G. S., & Bronstein, P. (1993). Family factors related to children's intrinsic/extrinsic motivational orientation and academic performance. *Child Development*, 64(5), 1461–1474.
- [18] Grigg, S., Perera, H. N., McIlveen, P., & Svetleff, Z. (2018). Relations among math self efficacy, interest, intentions, and achievement: A social cognitive perspective. *Contemporary Educational Psychology*, 53, 73-86.
- [19] Gutman, L. M., & McLoyd, V. C. (2000). Parents' management of their children's education within the home, at school, and in the community: An examination of African-American families living in poverty. *The Urban Review*, 32(1), 1–24.
- [20] Hackett, G., & Betz, N. E. (1989). An exploration of the mathematics self-efficacy/ mathematics performance correspondence. *Journal for Research in Mathematics Education*, 20, 261-273.
- [21] Heck, R. H., & Thomas, S. L. (2000). *An introduction to multilevel modelling techniques*. Mahwah, NJ: Erlbaum.
- [22] Hoover-Dempsey, K. V., & Sandler, H. M. (1995). Parental involvement in children's education: Why does it make difference? *Teachers College Record*, 97, 310–331.
- [23] Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, 41(2), 111-127.
- [24] Hill, N. E., Castellino, D. R., Lansford, J. E., Nowlin, P., Dodge, K. A., Bates, J. E., & Pettit, G. S. (2004). Parent academic involvement as related to school behavior, achievement, and aspirations: Demographic variations across adolescence. *Child Development*, 75(5), 1491–1590.
- [25] Hill, N. E., & Tyson, D. F. (2009). Parental involvement in middle school: A meta-analytic assessment of the strategies that promote achievement. *Developmental Psychology*, 45(3), 740-763.
- [26] Jansen, M., Lüdtke, O., & Schroeders, U. (2016). Evidence for a positive relation between interest and achievement: Examining between-person and within-person variation in five domains. *Contemporary Educational Psychology*, 46, 116-127.
- [27] Jodl, K. M., Michael, A., Malanchuk, O., Eccles, J. S., & Sameroff, A. (2001). Parents' roles in shaping early adolescents' occupational aspirations. *Child Development*, 72(4), 1247–1265.
- [28] Kim, Y. J., & Kim, J. W. (2013). The mediating effects of academic failure tolerance on the relationships between irrational beliefs, perceived parents' achievement pressure and the school adjustment of middle school students. *Studies on Korean Youth*, 24(2), 119–148.
- [29] Krapp, A. (2002). Structural and dynamic aspects of interest development: Theoretical considerations from an ontogenetic perspective. *Learning and Instruction*, 12(4), 383–409.

- [30] Kung, H. Y. (2009). Perception or confidence? Self-concept, self-efficacy, and achievement in mathematics: A longitudinal study. *Policy Futures in Education*, 7(4), 387-398.
- [31] Lee, J., & Stankov, L. (2013). Higher-order structure of noncognitive constructs and prediction of PISA 2003 mathematics achievement. *Learning and Individual Differences*, 26, 119-130.
- [32] Lopez, F. G., Lent, R. W., Brown, S. D., & Gore, P. A. (1997). Role of social-cognitive expectations in high school students' mathematics-related interest and performance. *Journal of Counseling Psychology*, 44(1), 44-52.
- [33] Maccoby, E. E. (1992). The role of parents in the socialization of children: A historical overview. *Developmental Psychology*, 28(6), 1006-1017.
- [34] Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2005). Academic self-concept, interest, grades, and standardized test scores: Reciprocal effects models of causal ordering. *Child Development*, 76(2), 397-416.
- [35] Muthén, L., & Muthén, B. (2012). *Mplus user's guide* (7th ed.). Los Angeles, CA: Muthén & Muthén.
- [36] OECD (2005). *PISA 2003 technical report*. Paris: OECD Publishing.
- [37] OECD (2013). *PISA 2012 assessment and analytical framework: Mathematics, reading, science, problem-solving and financial literacy*. Paris: OECD Publishing.
- [38] OECD & UNESCO-UIS (2003). *Literacy skills for the world of tomorrow—Further results from PISA 2000*. Paris: OECD Publishing.
- [39] Pajares, F., & Miller, M. D. (1995). Mathematics self-efficacy and mathematics performance: The need for specificity of assessment. *Journal of Counseling Psychology*, 42(2), 190-198.
- [40] Patrick, H., Ryan, A. M., & Kaplan, A. (2007). Early adolescents' perceptions of the classroom social environment, motivational beliefs, and engagement. *Journal of Educational Psychology*, 99(1), 83-98.
- [41] Pietsch, J., Walker, R., & Chapman, E. (2003). The relationship among self-concept, self-efficacy, and performance in mathematics during secondary school. *Journal of Educational Psychology*, 95(3), 589-603.
- [42] Pinxten, M., Marsh, H. W., De Fraine, B., Van Den Noortgate, W., & Van Damme, J. (2014). Enjoying mathematics or feeling competent in mathematics? Reciprocal effects on mathematics achievement and perceived math effort expenditure. *British Journal of Educational Psychology*, 84(1), 152-174.
- [43] Royston, P. (2004). Multiple imputation of missing values. *Stata Journal*, 4(3), 227-241.
- [44] Rubin, D. (1987). *Multiple imputation for nonresponse in sample surveys*. New York: Wiley.
- [45] Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, 25(1), 54-67.
- [46] Schiefele, U., Krapp, A., & Winteler, A. (1992). Interest as a predictor of academic achievement: A meta-analysis of research. In K. A. Renninger, S. Hidi, & A. Krapp (Eds.), *The role of interest in learning and development* (pp. 183-212). Hillsdale, NJ: Lawrence Erlbaum Associates.
- [47] Schunk, D. H., & Pajares, F. (2009). Self-efficacy theory. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 35-54). New York: Routledge.
- [48] Sénéchal, M., & LeFevre, J. A. (2002). Parental involvement in the development of children's reading skill: A five-year longitudinal study. *Child Development*, 73(2), 445-460.
- [49] Shumow, L., & Miller, J. D. (2001). Parents' at-home and at-school academic involvement with young adolescents.

*Journal of Early Adolescence*, 21(1), 68–91.

- [50] Silinkas, G., & Kikas, E. (2019). Parental involvement in math homework: Links to children's performance and motivation. *Scandinavian Journal of Educational Research*, 63(1), 17-37.
- [51] Silinkas, G., Niemi, P., Lerkkanen, M. K., & Nurmi, J. E. (2013). Children's poor academic performance evokes parental homework assistance – But does it help? *International Journal of Behavioral Development*, 37(1), 44–56.
- [52] Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *The Journal of Educational Research*, 95(6), 323–332.
- [53] Steenkamp, J. B. E., & Baumgartner, H. (1998). Assessing measurement invariance in cross-national consumer research. *Journal of Consumer Research*, 25(1), 78-90.
- [54] Weisberg, S. (2005). *Applied linear regression*. New York: Wiley.
- [55] White, H. (1982). Maximum likelihood estimation of misspecified models. *Econometrica*, 50, 1–25.
- [56] Wilder, S. (2014). Effects of parental involvement on academic achievement: A meta-synthesis. *Educational Review*, 66(3), 377–397.
- [57] Wigfield, A., Eccles, J. S., Yoon, K. S., Harold, R. D., Arbretton, A. J., Freedman-Doan, C., & Blumenfeld, P. C. (1997). Change in children's competence beliefs and subjective task values across the elementary school years: A 3-year study. *Journal of Educational Psychology*, 89(3), 451–469.
- [58] Wu, M. (2005). The role of plausible values in large-scale surveys. *Studies in Educational Evaluation*, 31(2), 114–128.
- [59] Yan, W., & Lin, Q. (2005). Parent involvement and mathematics achievement: Contrast across racial and

ethnic groups. *Journal of Educational Research*, 99(2), 116–127.