OSIPP Discussion Paper: DP-2017-E-003

Relationships between Parental Involvement and Academic Achievement among Elementary and Middle School Students

October 15, 2017

Midori Otani

Ph.D. in Osaka School of International Public Policy (OSIPP)

【Keyword】Parental Involvement, TIMSS, Elementary school, Middle school, Mathematics, Science, Japan

【JEL Codes】I21

【Abstract】This study investigates how parental involvement is associated with academic achievement by comparing the associations of parental involvement across three criteria: elementary and middle school (school level), male and female (gender), and math and science (subject). Also, it examines whether students' attitudes towards the subjects and academic aspiration mediate the relationship. A nationally representative sample of elementary and middle school children in Japan (1,884 female students and 140 schools and 1,894 male students and 139 schools in fourth grade, and 1,812 female students and 133 schools and 1,789 male students and 131 schools in eighth grade) from Trends International Mathematics and Science Study (TIMSS) 2011 was used for the analysis. Results show that parental involvement is associated with students' educational outcome. Students' attitude and aspiration mediate the associations between parental involvement and academic achievement. The associations between parental involvement and academic achievement vary according to the school level, gender, and the subjects. Especially, different association between monitoring types of involvement and achievement is found between elementary and middle school.

Acknowledgments: I would like to thank Hisakazu Matsushige, Tetsuya Matsubayashi, and Tsunehiro Otsuki of Osaka University for their helpful comments.

Correspondence: Midori Otani
Osaka School of International Public Policy, Osaka University, 1–31 Machikaneyama, Toyonaka, Osaka 560–0043, JAPAN.
E-mail: m.otanimidori@gmail.com

1. Introduction

Enhancing children's academic achievement is an important concern for parents, teachers, and policymakers. To achieve higher achievement, it is essential to identify the factors that influence it. Parents are essential in children's daily lives and they play a significant role in their children's education. Hoover-Dempsey and Sandler (1995) states that parental involvement influences educational outcome through three mechanisms: modelling of school related behaviours and attitudes, reinforcing specific aspects of school learning, and instruction. Also, researchers actively encourage parental involvement to increase academic performance (e.g., Hoover-Dempsey et al., 2005; Blazer, 2009; Galindo and Sheldon, 2012).

Academic research, however, does not agree on the effects of the relationship. While there are studies that conclude that home-based parental involvement in children's education has positive impacts on school achievement (e.g., Wang and Sheikh-Khalil, 2014; Pong, 1997; Fantuzzo et al., 2004; McNeal, 2015; Castro et al, 2015), other studies show insignificant or negative associations (e.g., Domina, 2005; Shumow and Miller, 2001; Shumow et al., 2011; Galindo and Sheldon 2012), or mixed results (McNeal, 1999, 2014; Zhan, 2006; Fan, 2001; Ginsburg and Bronstein, 1993; Sui-Chu and Willms, 1996; Lee and Bowen, 2006). The discrepant results are attributed to several factors such as different measures of parental involvement, disregard for school levels (e.g., elementary and middle school) and gender, failure to capture indirect effects of parental involvement, and the inclusion of different school subjects within a single variable for academic outcome (e.g., Math and Reading). Understanding how parental involvement is associated with academic achievement will inform and help policymakers and schools to design more effective parental involvement strategies. Therefore, the estimates of its relations should be as accurate as possible.

The present study examines the associations of parental involvement (monitoring and communicating) with mathematics and science achievement using data from Trends International Mathematics and Science Study (TIMSS) 2011. The unique contribution of this

study is that it addresses the gaps pointed out above and obtain better estimators by comparing the associations of parental involvement across three criteria: elementary and middle school (school level), male and female (gender), and math and science (subject). Results show that parental involvement is associated with students' educational outcome. Students' attitude and aspiration mediate the associations between parental involvement and academic achievement. The associations between parental involvement and academic achievement vary according to the school level, gender, and the subjects. Especially, different association between monitoring types of involvement and achievement is found between elementary and middle school: the associations of monitoring and achievement and attitudes are more significant among elementary than middle school students, which suggests that elementary students reap more benefits more from it.

2. Definition of Parental Involvement

Parental involvement includes a range of practices by the parent toward their children that are intended to promote the latter's motivation and educational achievement such as discussing school with children and monitoring children's progress. Parental involvement is multidimensional, and that has made it difficult to define it (Hill and Taylor, 2004). For example, Epstein (2001) suggests six categories of involvement: parenting, communicating, volunteering, learning at home, decision making, and collaborating within the community. Grolnick and Sowiaczek (1994) describe three categories of involvement: behaviour, cognitive-intellectual, and personal.

Most commonly, parental involvement is categorised in home-based and school-based involvement (e.g., Hoover-Dempsey and Sandler, 1997; Galindo and Sheldon, 2012; Deslandes and Bertrad, 2005; Green and Walker, 2007; Pomerantz et al., 2007; Anderson and Minke, 2007; Dauber and Epstein, 1989; Shumow and Miller, 2001). School-based involvement includes practices taking place at school; for example, attending school events and conference, and

volunteering. Home-based involvement is related to practices taking place outside of school such as learning activities at home, reviewing the child's work, monitoring their progress, helping them with homework, and discussions about school events (Hoover-Dempsey and Sandler, 1997; Pomerantz et al., 2007).

The present study adopts the home-based versus school-based categorization. However, since school-based involvement can be dramatically affected by external reasons which cannot be controlled by this study (e.g., nonflexible work schedule of parents), it is not used as a measure of parental involvement. Home-based involvement does not have such related problems and should be a better indicator of the actual outcomes. In this study, home-based involvement includes *communication with children about schoolwork* (communicating) and *monitoring their homework* (monitoring). Communicating and monitoring are commonly used as measures of parental involvement (e.g., McNeal, 2014; Sui-Chi and Willms, 1996). They are examined both as part of multidimensional index and as separate variables. This is because even though parental involvement is a multidimensional, the inclusion of too many measures (e.g., checking children's homework to talking about school) could make it hard to interpret its effects.

3. Literature Review

Even though a number of studies investigated the erelationships between parental involvement and academic achievement, five important gaps that prevent a more comprehensive understanding of the matter remain unaddressed: 1) previous studies use different definitions of parental involvement, 2) previous studies do not take school subjects into account separately, 3) previous studies do not consider school levels, 4) previous studies do not consider mediation effects, 5) previous studies do not consider gender difference. The details about those gaps in literature are discussed below.

3.1 Associations of Home-based Parental Involvement and Academic Achievement

A number of studies have examined the relationships of home-based parental involvement

and educational achievement, showing inconsistent results. While some studies showed a positive association between the two (e.g., Wang and Sheikh-Khalil, 2014; Pong, 1997; Fantuzzo et al., 2004; McNeal, 2015; Castro et al, 2015), other studies showed insignificant, negative, (e.g., Domina, 2005; Shumow and Miller, 2001; Shumow et al., 2011; Galindo and Sheldon 2012), or mixed results (McNeal, 1999, 2014; Zhan, 2006; Fan, 2001; Ginsburg and Bronstein, 1993; Sui-Chu and Willms, 1996; Lee and Bowen, 2006). For example, Wang and Sheikh-Khalil (2014) found that home-based involvement is positively associated with GPA. On the other hand, Shumow and Miller (2001) reported a negative association between home-based parental involvement and GPA and academic achievement. Finally, Shumow, et al. (2011) did not find a significant relationship between home-based involvement and science grades.

One possible reason for the inconsistent results is that studies employ different measures and definitions of parental involvement. While some studies used a single measure of parental involvement (e.g., Domina, 2005) or a measure composed of similar types of involvement (e.g., Pong, 1997; Sui-Chu and Willms, 1996; Fan, 2001; Jung and Zhang, 2016; Plunkett et al., 2009), others used an index that includes various types of involvement, from setting aside time for children to do homework to visiting museums (e.g., Galindo and Sheldon, 2012; Wang and Sheikh-Khalil, 2014). Using a measure that includes various types of involvement make it difficult to interpret the precise effects of a particular measure (Sui-Chu and Willms, 1996) and it can also bring different results.

In addition to this, the results are also likely to differ depending on the subjects. For example, parental monitoring of homework is positively associated with a reading achievement, but is negatively or not significantly associated with a mathematics achievement (Zhan, 2006; Sui-Chu and Willms, 1996). Therefore, it is also important to take into account the outcome variables to understand the effects of parental involvement precisely.

3.2 School Level

How parents get involved and the effects of their involvement may differ depending on the children's school level (Hill and Taylor, 2004; Patall et al., 2008). For example, middle school students preparing for high school entrance exams, and elementary school students learning basics are likely to receive different types of involvement. Also, compared to elementary school students, middle school students are more developed cognitively and have a higher sense of efficacy, hence their need for direct parental involvement decrease (Hill and Tyson, 2009). Likewise, when children get older, they become more peer-oriented and less interested in accepting obvious help (Hoover-Dempsey and Sandler, 1995).

Considering these results, the effects of parental involvement are likely to change according to the developmental changes. Hoover-Dempsey and Sandler (1995) claim that parental involvement must be appropriate for the child's development stage and be perceived as appropriate by the child to have a positive impact. In other words, the effects of monitoring may change according to school level because the necessity of direct involvement for older children decreases over time. The problem is that previous studies bundled data of children from multiple school levels, making it impossible to identify these differences. Comparing results of different studies that analysed samples of children from a single school level could be a solution, but, this task is unpractical given that definitions and measurements differ dramatically across studies. Due to the reasons above, it is still unclear how parental involvement is associated with achievement across school levels.

There are only a few studies that investigated the association between parental involvement and academic achievement across the different school levels and they show different associations at different school levels. Muller (1998) found that talking about school with children is positively associated with mathematic scores in eighth grade but is insignificant for tenth grade. He also found gender-based differences: talking about school is associated positively with math scores of female tenth graders but negatively with the score of male tenth graders. However, the

studies did not examine indirect effects of parental involvement on the score. On the other hand, Núñez et al. (2015) examined both direct and indirect effects of parental involvement in homework at different school levels and found different associations according to different school levels. Student homework behaviours (time spent on homework completion and homework time management) mediate the association between parental involvement in homework and academic achievement in middle and high school but not in elementary school. In addition to this, homework support was positively and directly associated with academic achievement at middle and high school but not at elementary school. However, their measurement of academic achievement is composed by several different subjects, which makes unclear how the associations of parental involvement vary across school subjects. The same can be said of gender differences.

3.3 Students' Attitude and Aspiration

Grolnick et al. (1991) suggested parental involvement has an impact on children's attitudes and motivation toward school rather than directly on academic achievement. Researchers argue that parents transmit their values to children by their involvement in activities with their children (e.g., Eccles et al., 1983; Grolnick and Slowiaczek, 1994). In other words, parent-child communication regarding education conveys the importance of schooling to the child (McNeal, 1999, 2014). When the parents talk to or ask their children about school, children are likely to notice the importance of it since their parents show interests toward it, and it is associated with the children's attitude towards education.

In fact, a number of empirical studies support the positive relatiions of parental involvement and children's attitude and motivation (Ginsburg and Bronstein, 1993; Simpkins et al., 2015; Spera, 2006; Gonzalez et al., 2002; Frenzel et al., 2010; Grolnick and Slowiaczek, 1994; Grolnick et al, 1991) and educational aspiration (Hill et al., 2004; Berzin, 2010; Hill and Wang, 2015; Frostick et al., 2016; McNeal, 2015). For example, Spera (2006) found that parental monitoring,

defined as checking homework and keeping track of children's activities, is positively associated with their interest in school classes. Likewise, Simpkins et al. (2015) found that parental involvement in scientific subjects positively predicted the value adolescents placed on it. Hill and Wang (2015) found that monitoring, defined as providing clear and consistent guidelines and maintaining knowledge about youth's activities, is positively associated with educational aspiration.

In addition to this, accumulated research suggests that attitudinal and motivational variables such as attitude towards a subject (Lipnevich et al., 2016; Singh et al., 2002), enjoyment (García et al., 2016; Villavicencio and Bernardo, 2013), domain-specific values (Steinmayr and Spinath,2009), intrinsic motivation (Lloyd and Barenblatt, 1984) , and educational aspiration (Leung et al., 2010; Jung and Zhang, 2016) predict academic achievement and grades positively. For example, García et al. (2016) found that enjoyment of mathematics predicted mathematics achievement positively among upper elementary school children. Also, Singh et al. (2002) found that mathematics attitude and interest predicted mathematics achievement positively, and science attitude and interest is indirectly associated with science achievement positively through enhancing academic time. Based on these findings, parental involvement is likely to be associated with academic achievement indirectly through affecting the children's attitudes and it is important to take these effects into account.

Some studies investigated the indirect associations of parental involvement and academic achievements through students' motivational resources, behaviour, and aspiration (Grolnick and Slowiaczek, 1994; Gottfried et al., 1994; Hill and Wang, 2015; Jung and Zhang, 2016; Grolnick et al., 1991; Wang and Sheikh-Khalil, 2014; Núñez et al., 2015). These studies largely found indirect positive effects of parental involvement through the mediating factors. For example, Wang and Sheikh-Khalil (2014) found that parental involvement is associated with GPA positively through enhancing educational engagement. Jung and Zhang (2016) found indirect effects of parental involvement on academic achievement through educational aspiration.

However, most studies did not examine how associations differ across different school levels. How children perceive parental involvement may differ at different school level because of different senses of efficacy, different needs for direct parental involvement, and different cognitive development. Therefore, the associations between parental involvement, attitudes, and achievement may also differ at different school levels.

3.4 Students' Gender

It is likely that perception of parental involvement and its associations also vary among male and female children. Children face a number of unique developmental challenges especially in their adolescence and gender affects how they manage all of these challenges (Perry and Pauletti, 2011). For example, Frydenber and Lewis (1991) found that there is a difference between the ways in which boys and girls cope with demands and stress; girls seek more social support and are more likely than boys to focus on relationships. Also, girls experience higher pressure and demands from school than boys (Wiklund et al., 2012).

Few studies have focused on gender differences between parental involvement and academic achievement (Muller, 1998; Moon and Hofferth, 2016 ; Jung and Zhang, 2016). For example, Muller (1998) found that female students' learning of mathematics at grades 10 to 12 are associated more closely with verbal interaction and supportive involvement, whereas the male students' gains are associated with social control and guidance. Moon and Hofferth (2016) found that parental involvement at home benefited boys' reading and mathematics score but it did not have the same benefit for girls throughout all early elementary school years. However, the index of parental involvement used in the study was composed by items focused on only daily living activities such as frequency of telling stories and playing games, and not school related involvement. Jung and Zhang (2016) examined 8-12 years old children and found that parental involvement, defined as the frequency of parental involvement in selecting courses, school activities, and things children study in class, predicted academic achievement positively among

girls but did not find the significant direct associations for boys.

4. Purpose of the Present Study

The present study intends to address the gaps pointed out in the previous section by examining students in elementary and middle school separately utilising the same measurement of home-based parental involvement. Also, the study takes into account the indirect effects of parental involvement and examines whether students' educational attitude and aspiration mediate the associations between home-based parental involvement and mathematics and science achievements. It also investigates male and female students separately. This study uses two measures for parental involvement: *communication with children about schoolwork* (communicating) and *monitoring their homework* (monitoring). Data for these two are taken from questionnaires that asked children about the frequency that they experience these involvements.

This study is organised around the following three research questions. 1) Do students' attitude and aspiration mediate the associations between home-based parental involvement and academic achievement? 2) How the associations vary between elementary and middle school? 3) Are the associations of parental involvement different between males and females? Based on the literature, it is hypothesised that parental involvement is associated with academic achievement positively through affecting student's attitude and aspiration (Figure 1) and that the associations would vary by the school level. Previous studies suggest that middles school students need less direct assistance compared to elementary students. Therefore, it is hypothesised that monitoring types of involvement is more significantly associated with elementary school students than middle school students. Also, since studies show that female children seek more social support (Lewis, 1991) and experience higher pressure and demands from school than boys (Wiklund et al., 2012), it is expected that communicating types of involvement would be more significantly associated with females than males.

5. Method

5.1 Data

This study uses the Japanese sub-sample from Trends International Mathematics and Science Study (TIMSS) 2011. The survey was conducted by the International Association for the Evaluation of Educational Achievement (IEA). TIMSS is an international assessment of student achievement in mathematics and science in the fourth and eighth grades. It also collects a wide range of information from students, teachers and school principals. This study uses the Student and the School questionnaires. A two-stage random sample design was employed to collect the sample. Schools were sampled in the first stage and, from each school, one class was selected in the second stage. After deleting missing data, the data of this study arrived at a sample of 1,884 female students from 140 schools and 1,894 male students from 139 schools in fourth grade, and 1,812 female students from 133 schools and 1,789 male students from 131 schools in eighth grade.

5.2 Variables

Academic Achievement

Mathematics and science achievement is the mean score of student's achievement in mathematics and science from the five plausible values. Plausible values are academic achievement scores which are created based on item response theory. In TIMSS 2011 each student responded to only a portion of the assessment item pool. Therefore, the TIMSS scaling approach uses multiple imputation (plausible values) methodology to obtain students' scores (Foy et al., 2011). As a result, five plausible values were produced for each student.

Attitudes toward Mathematics and Science

Attitudes towards mathematics include six questions and attitudes towards science include seven questions from the student questionnaire. All of the questions began with "How much do you agree that…?" and the questions were: "you enjoy learning mathematics/science?"; "you

wish you did not have to study mathematics/science?" (inverse); "mathematics/science is boring?" (inverse); "you learn many interesting things in mathematics/science?"; "you like mathematics/science?"; "it is important to do well in mathematics/science?"; and "read about science in your spare time?". Answer categories were coded as follows: 1 = disagree a lot, 2 = disagree a little, 3 = agree a little, 4 = agree a lot. As for the third and the fourth question, the answer categories were coded inversely. Based on the questions, factor analysis was conducted separately for each gender and school levels. Factors with an eigenvalue greater than 1 were retained and it yielded a one-factor solution for all the groups and labelled as *attitudes toward mathematics* and *attitudes toward science*.

Educational Aspiration

The measure of educational aspiration was based on the question "How far in your education do you expect to go?" that was asked only to eighth graders. The responses are categorized according to years of schooling that students want to pursue as follows: 1 = lower than secondary school, 2 = technical college or junior college, 3 = university, 4 = graduate school.

Home-based Parental Involvement

As measures of home-based parental involvement, four questions from the student questionnaire that asked students to rate their perception of their parents' home-based involvement were used. The questions were asked and labelled as follow: "How often do your parents ask you what you learned in school?" (*Ask)*; "How often do you talk about your schoolwork with your parents?" (*Talk*); "How often do your parents make sure that you set aside time for your homework?" (*Time*); and "How often do your parents check if you do your homework?" (*Check*). Answer categories were coded as follows: 1 = Never or almost never, 2 = once or twice a month, 3 = once or twice a week, 4 = every day or almost every day.

Based on this, two component variables were also created. Among the four questions, *Ask* and

Talk are more correlated (0.55 for female and 0.52 for male fourth graders and 0.62 for female and 0.6 for male eighth graders), as well as *Time* and *Check* (0.49 for female and 0.42 for male fourth graders and 0.73 for female and 0.67 for male eighth graders). Therefore, two composite measures were created by principal component analysis: *Communicating* (*Ask* and *Talk*) and *Monitoring* (*Time* and *Check*). The correlation between the variables of parental involvement is shown in Appendix (Table A.1).

Control Variables

Several student and school variables were included in the models to control statistically for important background factors. The measure of socioeconomic status (SES) used in this study includes a number of books and materials related to educational well-being at home and the highest level of education completed by parents. The questions were answered by students. The number of books at home was coded as follows: 1 = 0-10 books, 2 = 11-25 books, 3 = 26-100 books, 4 = 101-200 books, 5 = more than 200 books. Index of possessions at home was created through adding eleven questions that ask if students have a specific item that is relevant to educational well-being (e.g., a computer and a desk for his/her own etc.). Since the distribution of addition of the eleven questions is not normal but truncated, a dummy variable was created to capture the effect of external value and it is labelled as *Possessions at home 11*. The highest level of education completed by the mother and father was asked but only to eighth grade students. Binary variables were created for each educational level for both the mother and the father. More than 30% of students in the sample did not know one of their parents' highest levels of education. Since it is too large to drop from the data, a dummy variable was created as unknown instead of dropping them from the data. It enables to control effects of parents' educational level while keeping the students that do not know it in the sample.

Studies show that children who are younger at school entry tend to perform worse academically (Lee and Fish, 2010; Kawaguchi, 2011). In Japan, school starts in April and

children enter first grade of elementary school if, and only if they have completed six years of life by April 1 of that year. In this study, in order to take into account for the effects of being younger in the classroom, a dummy variable was created for students born between January 1 and April and coded as 1 = yes and 0 = no.

Experiences of being bullied include six questions from the student questionnaire. All of the questions began with “During this year, how often…?” and the questions were: “were you made fun of or called names at school?”; “were you left out of games or activities by other students at school?”; “did someone spread lies about you at school?”; “was something stolen from you at school?”; “were you hit or hurt by other student(s) at school?”; and “were you made to do things you didn't want to do by other students at school?”. Factor analysis was conducted with the questions separately for each gender and school levels. Factors with an eigenvalue greater than 1 were retained and it yielded a one-factor solution for all the groups. The variable is used to control attitudes towards mathematics and science and educational aspiration since previous studies show that experience of being bullied is negatively associated with academic motivation (Skues et al., 2005: Young-Jones et al., 2015)

The total enrolment of students was divided into hundreds. A Percentage of students from economically disadvantaged homes was coded as follows: 1 = 0 to 10%, 2 = 11 to 25%, 3 = 26 to 50%, 4 = more than 50%. The immediate area in which the school was located was labelled as location of school and coded as follows: 1 = small town, 2 = medium size city, 3 = suburban, 4 = urban. The income level of the school's immediate area was coded as follows: 1 = low, 2 = middle, 3 = high. Class size is the number of students in the class. Different types of schools (only for eighth grade) were coded as follows: 1 = private/national, 0 = public. All the questions were answered by a school principal. *School-P* is a variable that shows the average of the level of schooling of the parents whose children study in the same school. The variable was created by the following steps. First, level of schooling of both the mother and the father were coded according to the following scores: 1 = elementary school or did not complete any school, 2 =

lower-secondary school, 3 = upper-secondary school, 4 = junior college, 5 = university or college, and 6 = graduate school. Second, the score of both parents were summed up and the average of those numbers was presented for each school. A variable for missing value (*unknown*) was created and not considered in the calculation of *School-P*.

All the control variables are used to control students' grade, attitude and aspiration except for experiences of being bullied that is only used to control attitude and aspiration. SES variables are also used to control parental involvement.

5.3 Estimation Method

Due to the sampling procedure used in TIMSS 2011, a weighted generalised multilevel structural equation model analysis (with an ordered logit link for estimating eighth graders educational aspiration) was conducted by Stata 14 to analyse the associations of parental involvement and educational outcome. Since the data structure is hierarchical, students within same school may share similarities and it must be considered in the analytic methods. Multilevel model examines the variance between individuals and groups and it gives accurate estimate when examining nested data (Heck and Thomas, 2015). Generalised structural equation modelling (GSEM) is a version of structural equation modelling (SEM) that allows for broader applications. SEM can depict relationships among variables by using various types of models and testing patterns of relationships among a set of observed and latent variables (Schumacker and Lomax, 2010). OLS regression is limited in that and it does not allow for simultaneous examination of multiple mediational chains (Bryan et al., 2007). SEM, on the other hand, examines direct and indirect associations simultaneously and tests multiple mediators, multiple dependent variables, complex mediational chains, and specific indirect associations within those complex chains (Bryan et al., 2007; Gunzler et al., 2013). Instrumental variables (IV) could be another option, but in order to use IV, the structure of the model has to be decided beforehand. SEM allows the examination of complex structured models more flexible. Below is the

equations used for the estimation:

$$Y_{ij} = \beta_0 + \beta_1 S_{0j} + \beta_2 P_{ij} + \beta_3 A_{ij} + \beta_4 EA_{ij} + \beta_5 X_{1,ij} + \beta_6 Z_{1,0j} + \varepsilon_{ij} \quad (1)$$

$$P_{ij} = \theta_0 + \theta_1 X_{2,ij} + \tau_{ij} \quad (2)$$

$$A_{ij} = \gamma_0 + \gamma_1 P_{ij} + \gamma_2 X_{3,ij} + \gamma_3 Z_{2,0j} + u_{ij} \quad (3)$$

$$EA^*_{ij} = \delta_0 + \delta_1 P_{ij} + \delta_2 X_{4,ij} + \delta_3 Z_{3,0j} + \epsilon_{ij} \quad (4)$$

$$EA_{ij} \begin{cases} 1 \; if \; EA^*_{ij} \leq \mu_1 \\ 2 \; if \; \mu_1 < EA^*_{ij} \leq \mu_2 \\ 3 \; if \; \mu_2 < EA^*_{ij} \leq \mu_3 \\ 4 \; if \; \mu_3 < EA^*_{ij} \end{cases}$$

Where:

Y_{ij} = mathematics and science achievement of student *i* in school *j*

$\beta_{0j}, \theta_0, \gamma_0 \text{and } \delta_0$ = intercept

S_{0j} = latent variable (random intercept) of school which varies at the school level, which is consistent within school

P_{ij} = parental involvement

A_{ij} = adolescents' attitudes towards mathematics and science

EA^*_{ij} = latent variable of adolescents' educational aspiration, whose values determine what the observed ordinal variable EA_{ij} equals

EA_{ij} = adolescents' educational aspiration (only for eighth grade)

$X_{1,ij}$ = vector of the student level control variables for Eq. (1)

$X_{2,ij}$ = vector of the student level control variables for Eq. (2)

$X_{3,ij}$ = vector of the student level control variables for Eq. (3)

$X_{4,ij}$ = vector of the student level control variables for Eq. (4)

$Z_{1,0j}$ = vector of the school level control variables for Eq. (1)

$Z_{2,0j}$ = vector of the school level control variables for Eq. (3)

$Z_{3,0j}$ = vector of the school level control variables for Eq. (4)

$\varepsilon_{ij}, \tau_{ij}, u_{ij}$, and ϵ_{ij} = residual term

The direct and indirect associations are all examined in a single model (Figure 2) by using Eq. (1), (2) and (3) for fourth grade and by using Eq. (1), (2), (3) and (4) for eighth grade.[1] β_1 is automatically constrained to be 1. Such constraints are automatically supplied by Stata 14 to identify the latent variable. The final models were decided among converged models based on Akaike Information Criterion (AIC) (Akaike, 1987). The AIC measure is used to compare models with different numbers of latent variables. It aims to identify those models that represent a good compromise between model fit and model complexity and selects most relevant variables to prevent overfitting (Garamszegi and Mundry, 2014; Sauerbrei et al., 2007). Lower values for AIC indicate a better model fit. Therefore, some control variables that are not important are dropped from the model based on the AIC. The results did not change significantly from the models that use all the variables (see Appendix from Table A.2 to A.10 for the detailed results). Each value of AIC for the final models are as follows: Model 1(71668), Model 2 (71686), Model 3 (72815), Model 4 (72826), Model 5 (70166), Model 6 (70176), Model 7 (71672), Model 8 (71696), Model 9 (164053), Model 10 (169972), Model 11 (142262), Model12 (142348), Model 13 (139422), Model 14 (139405), Model 15 (164742), and Model 16 (171096)[2].

5.4 Descriptive Statistics

Table 1 (for fourth grade) and 2.2 (for eighth grade) provides the weighted descriptive statistics for each grade. It shows that parents of elementary school children are more involved

[1] Estimation of similar models are also conducted and the results are consistent with the final one.

[2] Models 1 to 8 estimate fourth graders and models 9 to 16 estimate eighth graders. Models 1 to 4 and 9 to 12 estimate for mathematics. Model 5 to 8 and 13 to 16 estimate for science. Odd number models use the four types of involvement (*Ask*, *Talk*, *Time* and *Check*) and even number models use the aggregated parental involvement (*Communicating* and *Monitoring*). Model 1, 2, 5, 6, 9, 10, 13, and 14 estimate males and the 3, 4, 7, 8, 11, 12 estimate females.

in their children's education. The difference is especially clear for the frequency of checking if their children do their homework: parents of elementary school children do it more frequently than parents of middle school children. Among the four types of involvement, checking homework is the most frequent type of involvement in elementary school. For middle school, talking about schoolwork is the most frequent type of involvement. Descriptive statistics show that parents change types of involvement according to their children's school level. Also, parents ask about what their children learned in school and about school work more frequently to female than to males. As for mathematics and science achievement, means of male students' achievements are higher than female's in both elementary and middle school.

6. Results

Results are discussed at 5% significant level.

Fourth Grade

The results for mathematics achievement are illustrated in Figure 3 for male students and Figure 4 for females (the detailed results are shown in Table 4). The results for science achievement are illustrated in Figure 5 for males and Figure 6 for females (the detailed results are shown in Table 5). Results show that parental involvement is associated with mathematics and science achievement directly and also indirectly through attitude for both males and females. Also, the associations are partly different between males, females and the subjects.

Largely, *Communicating* type of involvement such as *Talk* and *Ask* is associated with attitude positively. That is when more parents ask children about what they learned in school and talk about their schoolwork, children have more positive attitudes towards the subjects. On the other hand, positive and direct associations are found between *Monitoring* type of involvement such as *Check* and achievement That is children gain higher achievement when their parents check their homework more. Some of these types are also associated with attitude. *Time* is positively

associated with mathematics and science attitude of male students. Also, it is positively associated with female students' science achievement. In addition to this, *Check* is positively associated with female students' science attitude and *Monitoring* is associated with science achievement for both males and females. However, negative associations are also found. *Communicating* and *Talk* are negatively associated with achievement except for female students' mathematics achievement (model 3) (see Figure 4).

As for the control variables, some differences are found especially between males and females. Measures of socioeconomic status are largely associated with achievement and attitudes. Number of possessions at home is positively associated with achievement and attitudes except to science attitudes of females. Number of books at home is positively associated with achievement and female students' attitude. It may indicate that females benefit more from books. As for other control variables, children born between January 1 and April 1 are negatively associated with achievement. However, it is positively associated with male students' science attitudes. Experience of being bullied is negatively associated with female students' attitudes and male students' mathematics attitudes. Total enrolment of students is positively associated with male students' attitudes. Location of school is positively associated with mathematics achievement. That is when school is located in a bigger city, students get higher achievement. Income level of school area is positively associated with achievement and male students' science attitudes. Interestingly, larger class size is negatively associated with male students' attitudes, however it is positively associated with female students' mathematics achievement.

Eighth Grade

The results for mathematics achievement are illustrated in Figure 7 for males and Figure 8 for females (the detailed results are shown in Table 6 for males and Table 7 for females). Also, the results for science achievement are illustrated in Figure 9 for males and Figure 10 for females

(the detailed results are shown in Table 8 for males and Table 9 for females). Results show that parental involvement is indirectly associated with mathematics and science achievement through attitude and aspiration for both males and females. Also, the associations are partly different between males, females and the subjects.

Talk and *Communicating* are positively and significantly associated with attitude. That is when more parents ask children about what they learned in school and talk about their schoolwork, children have more positive attitudes towards the subjects. *Talk* and *Communicating* are also positively associated with aspiration except that *Talk* is not significantly associated for females. *Monitoring* and *Check* are positively associated with male students' mathematics attitude and female students' science attitudes. However, negative associations are also found. *Monitoring* is negatively associated with male students' mathematics achievement and *Check* is negatively associated with female students' mathematics achievement.

As for the control variables, associations are largely similar between gender and subjects. Socioeconomic measures are associated with achievement, attitude and aspiration. Number of possessions at home is positively and significantly associated with achievements, attitudes and aspiration except for male students' achievement and female students' science attitude. Number of books at home is positively associated with achievements and aspiration. Also, it is positively associated with science attitudes. As for educational level of parents, largely, parents graduated higher than university is positively associated with aspiration. However, fathers graduated junior college is negatively associated with aspiration and mathematics achievement. Mothers graduated junior college is differently associated with males and females: it is positively associated with male students' achievement whereas negatively associated with female students' aspiration. Children born between January 1 and April 1 are negatively associated with male students' achievement. Attending private or national school is positively associated with aspiration and males students' mathematics achievement and attitudes. *School-P* is positively

associated with male students' achievement. That is male students gain higher achievement when the average of the level of schooling of the parents whose children study in the same school is higher. Higher income level is positively associated with female students' aspiration. Experience of being bullied and class size is not significantly associated even though there are some associations in fourth grade.

7. Discussion

This study investigated the associations of home-based parental involvement and academic achievement and how the association differs across three criteria: elementary and middle school (school level), male and female (gender), and math and science (subject). Also, it examined how students' attitudes and educational aspiration mediate the relationships between parental involvement and achievement. Results show that parental involvement is associated with students' educational outcome at both fourth and eighth grade regardless of gender and the subjects. Students' attitude and aspiration mediate the associations between parental involvement and academic achievement. However, the associations between parental involvement and academic achievement vary according to the school level, gender, and the subjects.

How monitoring types of involvements (*Time*, *Check* and *Monitoring*) are associated with the achievements differ between elementary and middle school. In elementary school, it is associated with the achievements both directly and indirectly through the attitudes. On the other hand, in middle school, it is positively associated with the achievements through the attitudes and aspiration. It may be attributed the fact that the fourth and eighth graders are at different developmental stages. Studies show that the levels of understanding of the purpose of doing homework are different depending on children's developmental stages (Warton, 1997; Xu, 2005). For example, Warton (1997) reported that when grades 2, 4 and 6 are asked whether it matters if someone else does all their homework, they generally agreed that they should

complete their own homework. However, their understanding of responsibility was not clear among younger students. More grade 6 children than younger children gave an internal justification such as they will not learn if someone else does their homework. Although some younger children answered the same, they are also likely to give an external justification such as the teacher would not like it if someone else does their homework. This indicates that younger children have not completely developed an understanding of the purpose of doing homework.

It is likely that children in elementary and middle school may perceive parental monitoring of their homework differently because of the different levels of understanding regarding the very purpose of doing homework. Since older students are more likely to understand the meaning of doing homework diligently, they might perceive the importance of education through their parents' monitoring activities, which in turn, enhances their attitudes. On the other hand, since younger children are less likely to have the same kind of understanding, monitoring will also influence achievement directly. In other words, they would write their homework because of external reasons such as to please their teachers and/or avoid parental reprehension, which would result in higher achievement without improving their attitudes. Finally, as hypothesised, the relations of monitoring and achievement and attitudes are more significant among elementary than middle school students, which suggests that elementary students reap more benefits more from it.

Overall, as for the patterns of the effects of parental involvement, more similarities are found between gender and the subject even though some differences are also found. As for the differences, in fourth grade, monitoring types of involvement are more associated with attitudes in science compared to mathematics. Also, females benefit slightly more from parental monitoring than males and males benefit slightly more from parental communicating than females. In eighth grade, *Check* and *Monitoring* are associated with mathematics attitudes for males, but not for females and science attitudes for females, but not for males. Also, *Talk* is associated with male students' aspiration but not females. Most of these differences are difficult

to interpret. However, contrary to what was hypothesised, it shows that communicating types of involvement are more significantly associated with males than females.

Some negative associations are also found only in the direct relationships between parental involvement and achievement. *Talk* and *Communicating* are negatively associated with achievement in elementary school. Among middle school students, *Check* is negatively associated with female mathematics achievement. *Monitoring* is negatively associated with male mathematics achievement. Negative association between monitoring and mathematics achievement is consistent with previous studies (Zhan, 2006; Sui-Chu and Willms, 1996). Negative associations between parental involvement and academic achievement are also found in other previous studies (Lee and Bowen, 2006; Shumow and Miller, 2001; Milne et al., 1986) For example, Milne et al. (1986) found that parental homework help is negatively associated with achievement and suggested that parent provide help when their children are not doing well academically. The negative associations found in this study can be explained in the same way. It is likely that the parents tend to communicate or monitor their children more when their children are not doing well academically.

The results of the study suggest the importance of taking into account school level, indirect associations of parental involvement, types of involvement, and students' gender to understand how parental involvement is associated with academic achievement. Therefore, investigating parental involvement without considering these factors may fail to capture the true mechanism of parental involvement. Also, the present study examines only the associations of parental discussion and monitoring. Further studies need to investigate the associations of other types of involvement on achievement for a better understanding of its mechanisms.

Limitation

Because of lack of data, the present study is unable to control the education level of parents of fourth grade students. For the same reason, this study could not examine subjects other than

mathematics and science. Different associations might be found when other subjects, such as English, are investigated and compared with the results of mathematics and science. Also, different patterns of gender differences might be found in different subjects. Therefore, further studies using data that includes other subjects are recommended.

Additionally, concerning the explanation for the negative association of parental involvement, it is not possible to analyse whether a problem of inverse causal relationship explained in the previous section applies to this case since cross-section data is used in the study. Likewise, even though it is also possible that parents get involved more when their children are good at mathematics and science and have higher educational aspiration, it was impossible to analyse such causality in this study because the data used in the present study does not include information of previous grades and achievements. Further study using panel data is needed in order to test the causal relationships.

8. Conclusion

This study investigated the associations of home-based parental involvement and academic achievement and how students' attitudes and educational aspiration mediate the relationships between parental involvement and mathematics and science achievement. Samples of elementary and middle school children were analysed separately and according to gender and two different subjects (mathematics and science). The analyses were conducted by using a weighted generalised multilevel structural equation model. Results show that parental involvement is associated with students' educational outcome. Students' attitude and aspiration mediate the associations between parental involvement and academic achievement. The associations between parental involvement and academic achievement vary according to the school level, gender, and the subjects. The notable difference is found between elementary and middle school: in the former, positive and significant associations of monitoring types involvement (parents making sure children set aside time for their homework and checking

homework) with academic achievement are found in both directly and indirectly (through enhancing attitudes towards subjects). In the latter, the positive and significant associations of the same types of involvement with achievement are found indirectly. Also, the associations of monitoring and achievement and attitudes are more significant among elementary than middle school students, which suggests that elementary students reap more benefits more from it. The results of the study suggest the importance of taking into account school level, indirect effects of parental involvement, types of involvement, and students' gender to understand how parental involvement is associated with academic achievement. Also, given the findings that the parental involvement, parental communicating and monitoring, are associated with both elementary and middle school students' educational outcome positively, schools and policy makers may need to develop policies to encourage parental involvement.

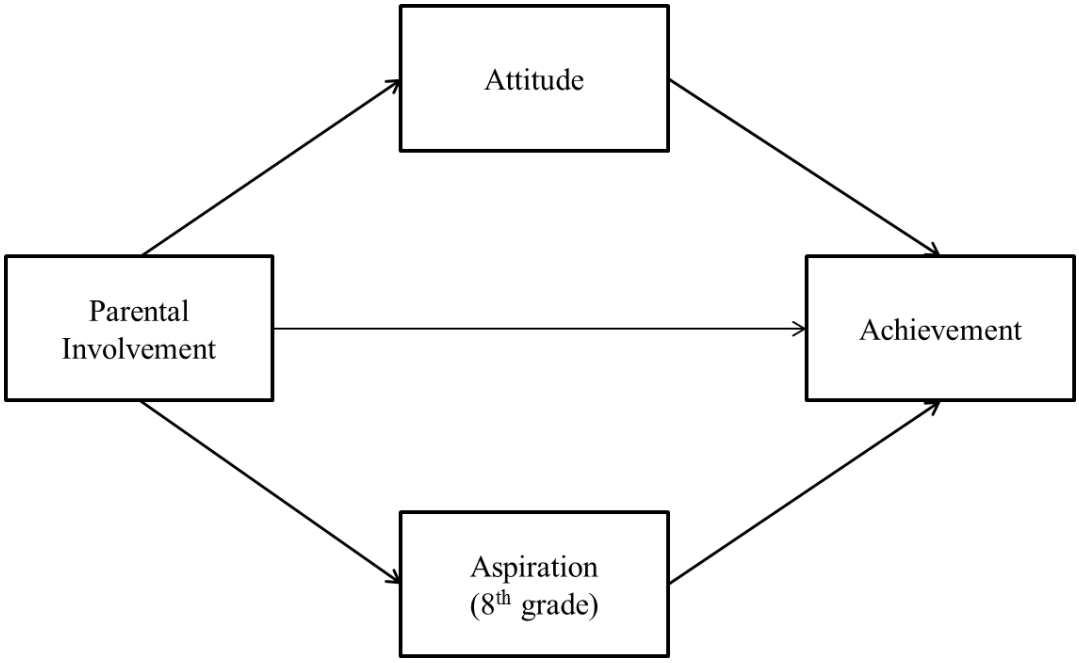


Figure 1 Hypothesised Model

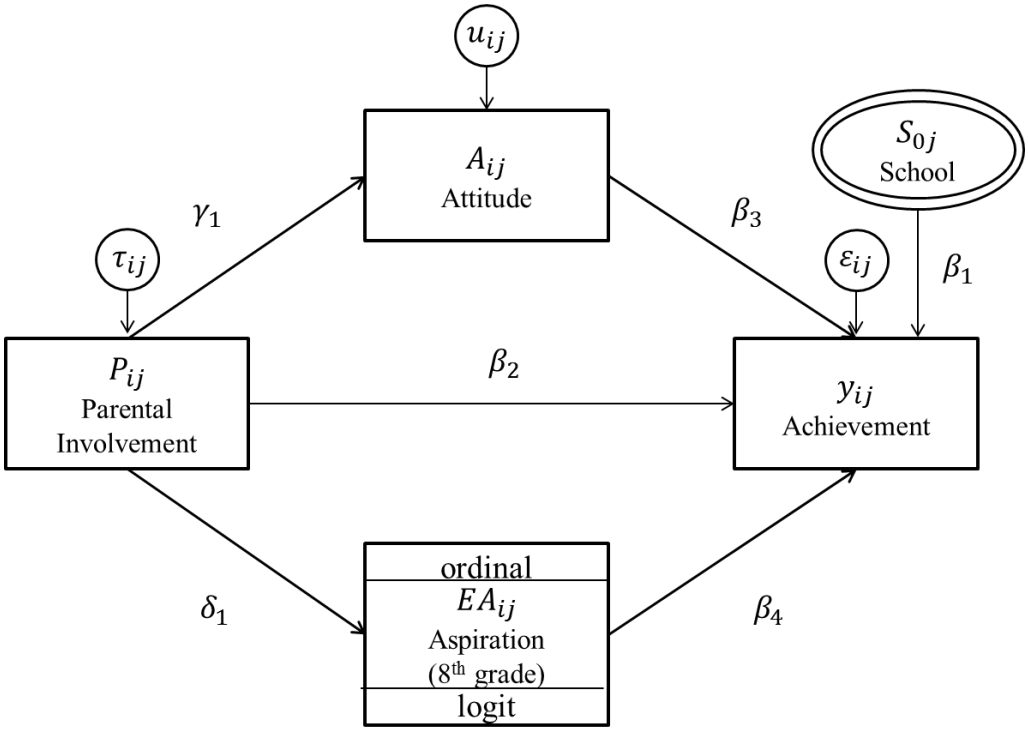


Figure 2 Model of the Associations of Parental Involvement and Adolescents' Educational Outcome

Control variables are omitted from the figure to facilitate visualization

Model 1 Model 2

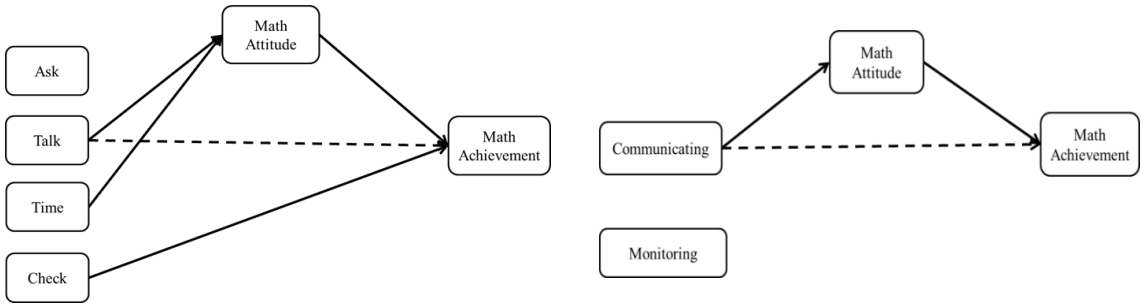


Figure 3 Model 1 and 2

SEM depicting mediation effects of academic attitude between parental involvement and mathematics achievement for fourth grade male students. Solid lines represent positive associations and dotted lines represent negative associations. Only significant paths ($p<.05$) are shown.

Model 3 Model 4

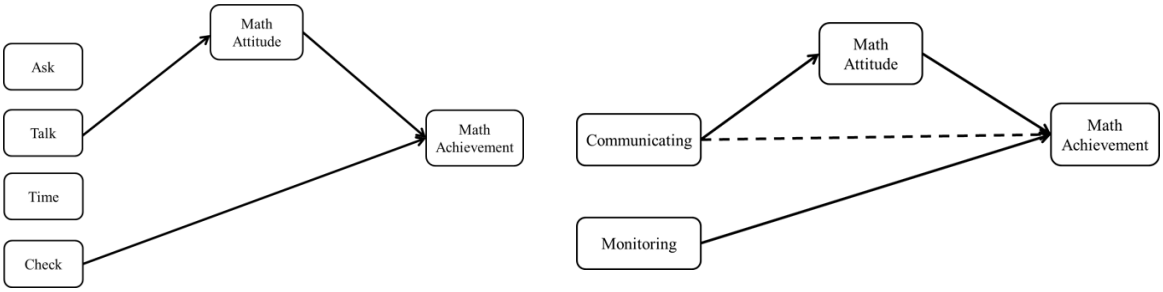


Figure 4 Model 3 and 4

SEM depicting mediation effects of academic attitude between parental involvement and mathematics achievement for fourth grade female students. Solid lines represent positive associations and dotted lines represent negative associations. Only significant paths ($p<.05$) are shown.

Model 5 Model 6

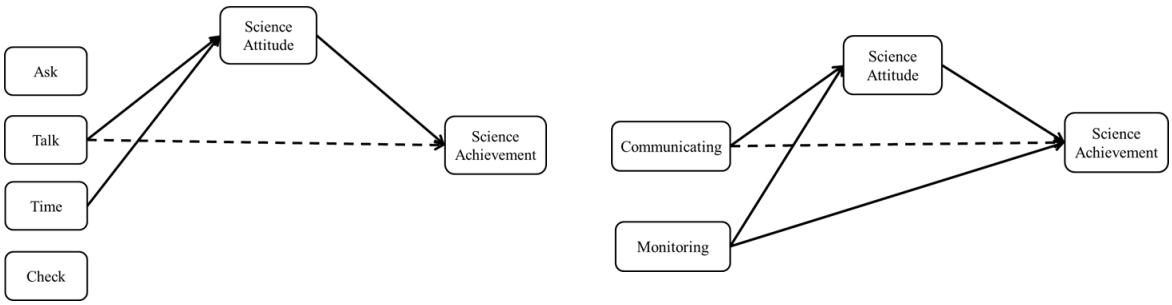


Figure 5 Model 5 and 6

SEM depicting mediation effects of academic attitude between parental involvement and science achievement for fourth grade male students. Solid lines represent positive associations and dotted lines represent negative associations. Only significant paths ($p<.05$) are shown.

Model 7 Model 8

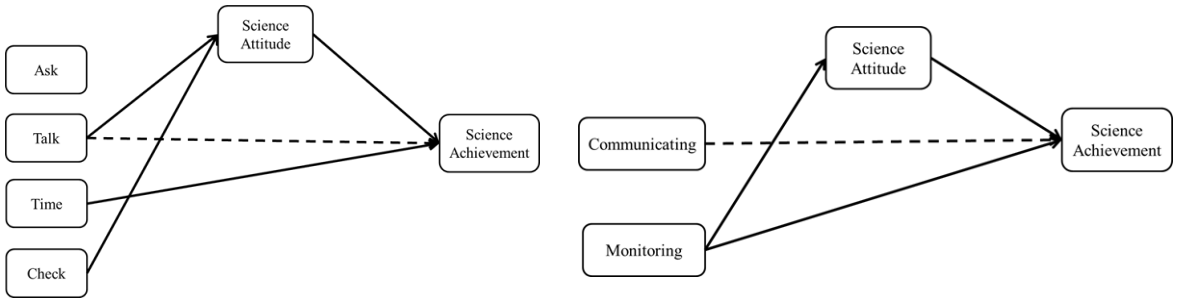
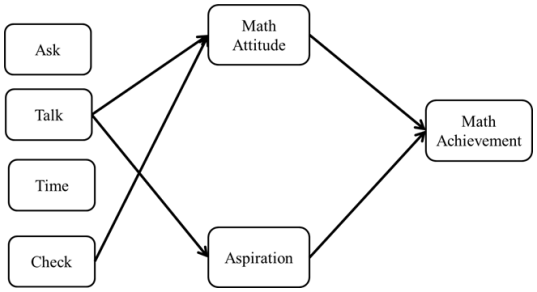


Figure 6 Model 7 and 8

SEM depicting mediation effects of academic attitude between parental involvement and science achievement for fourth grade female students. Solid lines represent positive associations and dotted lines represent negative associations. Only significant paths ($p<.05$) are shown.

Model 9



Model 10

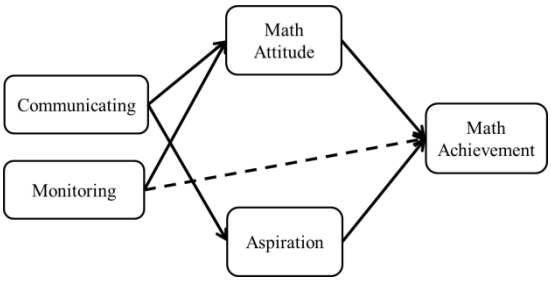
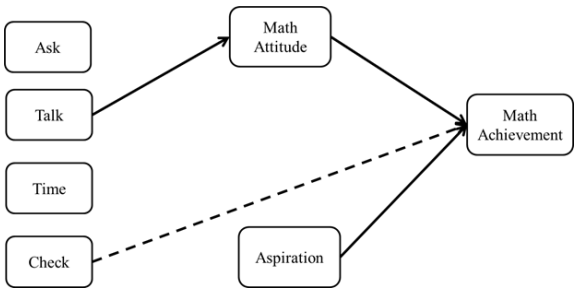


Figure 7 Model 9 and 10

SEM depicting mediation effects of academic attitude and aspiration between parental involvement and mathematics achievement for eighth grade male students. Solid lines represent positive associations and dotted lines represent negative associations. Only significant paths ($p<.05$) are shown.

Model11



Model 12

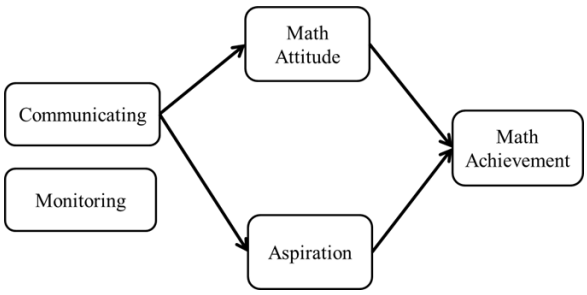
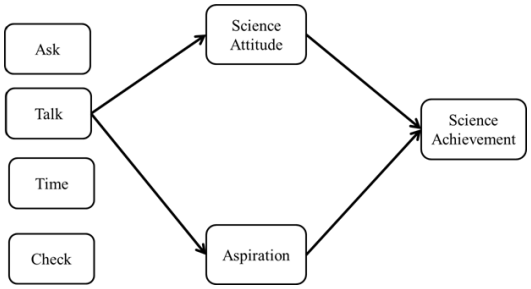


Figure 8 Model 11 and 12

SEM depicting mediation effects of academic attitude and aspiration between parental involvement and mathematics achievement for eighth grade female students. Solid lines represent positive associations and dotted lines represent negative associations. Only significant paths ($p<.05$) are shown.

Model 13



Model 14

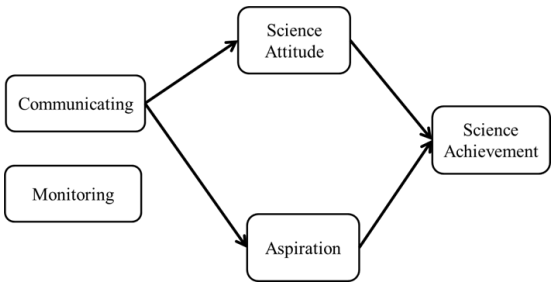
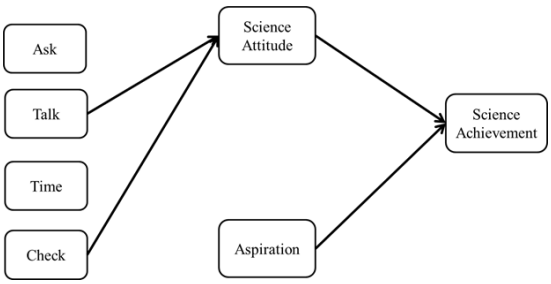


Figure 9 Model 13 and 14

SEM depicting mediation effects of academic attitude and aspiration between parental involvement and science achievement for eighth grade male students. Solid lines represent positive associations and dotted lines represent negative associations. Only significant paths ($p<.05$) are shown.

Model 15



Model 16

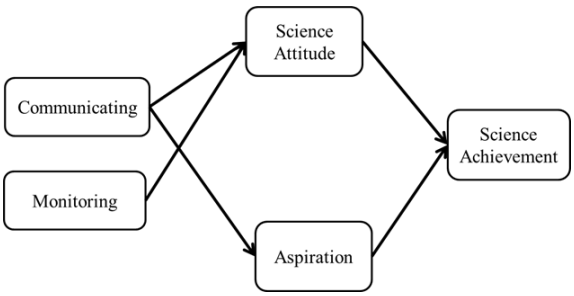


Figure 10 Model 15 and 16

SEM depicting mediation effects of academic attitude and aspiration between parental involvement and science achievement for eighth grade female students. Solid lines represent positive associations and dotted lines represent negative associations. Only significant paths ($p<.05$) are shown.

Table 1 Weighted Descriptive Statistics for Fourth Grade

(Female: N= 1,884 students and 140 schools, Male: N= 1,849 students and 139 schools)

	Female				Male			
Variable	Mean or %	Std. Dev.	Min	Max	Mean or %	Std. Dev.	Min	Max
Mathematics achievement	586.63	64.32	349.93	770.85	592.14	68.79	330.10	752.99
Science achievement	557.76	55.45	345.58	725.99	565.86	60.12	330.32	724.71
Parental involvement								
(Ask)Parents ask a student what you learned in school	2.67	1.01	1	4	2.52	1.05	1	4
(Talk)A student talks about schoolwork with parents	2.93	0.99	1	4	2.70	1.03	1	4
(Time)Parents make sure that a student set aside time for homework	2.25	1.26	1	4	2.23	1.25	1	4
(Check)Parents check if a student does homework	2.97	1.19	1	4	3.03	1.16	1	4
Attitudes toward mathematics								
How much do you agree that...								
you enjoy learning mathematics?	2.84	0.86	1	4	3.06	0.91	1	4
you wish you did not have to study mathematics?*	3.29	0.77	1	4	3.32	0.84	1	4
mathematics is boring?*	3.11	0.83	1	4	3.18	0.86	1	4
you learn many interesting things in mathematics?	2.88	0.84	1	4	3.02	0.88	1	4
you like mathematics?	2.69	0.99	1	4	3.01	0.98	1	4
it is important to do well in mathematics?	3.43	0.73	1	4	3.37	0.82	1	4
Attitudes toward science								
How much do you agree that...								
you enjoy learning science?	3.34	0.75	1	4	3.55	0.70	1	4
you wish you did not have to study science?*	3.48	0.68	1	4	3.53	0.72	1	4
you read about science in your spare time?	1.97	0.86	1	4	2.19	0.96	1	4
science is boring?*	3.42	0.71	1	4	3.45	0.77	1	4
you learn many interesting things in science?	3.28	0.81	1	4	3.40	0.82	1	4
you like science?	3.19	0.89	1	4	3.42	0.81	1	4
it is important to do well in science?	3.32	0.78	1	4	3.28	0.86	1	4
Number of books at home	2.73	1.04	1	5	2.79	1.09	1	5
Possessions at home (a computer, a desk etc.)	7.88	1.80	1	11	8.04	1.80	2	11
Possessions at home11	0.05		0	1	0.07		0	1
Children born between January 1 to April 1	0.25		0	1	0.23		0	1
Experiences of being bullied								
During this year, how often …								
were you made fun of or called names at school?	2.20	1.10	1	4	2.48	1.12	1	4
were you left out of games or activities by other students at school?	1.63	0.89	1	4	1.74	0.96	1	4
did someone spread lies about you at school?	1.54	0.85	1	4	1.83	1.02	1	4
was something stolen from you at school?	1.37	0.72	1	4	1.49	0.84	1	4
were you hit or hurt by other student(s) at school?	1.61	0.92	1	4	2.00	1.09	1	4
were you made to do things you didn't want to do by other students at school?	1.41	0.75	1	4	1.55	0.88	1	4
Total enrolment of students (in hundreds)	4.17	2.27	0.17	11.1	4.00	2.30	0.17	11.1
Location	2.28	0.94	1	5	2.30	1.00	1	5
Percentage of students from economically disadvantaged home	1.61	0.73	1	4	1.62	0.71	1	4
Income level of school's immediate area	1.89	0.46	1	3	1.89	0.46	1	3
Class size	27.54	6.79	4	39	27.22	6.77	7	39

Note: *Answer categories are inversed

Table 2 Weighted Descriptive Statistics for Eighth Grade

(Female: N= 1,812 students and 133 schools, Male: N= 1,789 students and 131 schools)

	Female				Male			
Variable	Mean or %	Std. Dev.	Min	Max	Mean or %	Std. Dev.	Min	Max
Mathematics achievement	568.79	76.89	307	820	575.50	83.08	162	828
Science achievement	555.19	67.83	329	751	564.73	73.98	143	795
Parental involvement								
(Ask)Parents ask a student what you learned in school	2.38	0.98	1	4	2.29	0.97	1	4
(Talk)A student talks about schoolwork with parents	2.68	0.94	1	4	2.39	0.96	1	4
(Time)Parents make sure that a student set aside time for homework	2.00	1.11	1	4	1.97	1.10	1	4
(Check)Parents check if a student does homework	2.13	1.16	1	4	2.16	1.15	1	4
Academic aspiration	5.70	1.54	0	9	5.72	1.89	0	9
Attitudes toward mathematics								
How much do you agree that...								
you enjoy learning mathematics?	2.34	0.86	1	4	2.63	0.92	1	4
you wish you did not have to study mathematics?*	2.57	0.88	1	4	2.86	0.91	1	4
mathematics is boring?*	2.52	0.81	1	4	2.74	0.89	1	4
you learn many interesting things in mathematics?	2.20	0.77	1	4	2.45	0.87	1	4
you like mathematics?	2.17	0.91	1	4	2.48	0.98	1	4
it is important to do well in mathematics?	3.24	0.75	1	4	3.32	0.79	1	4
Attitudes toward science								
How much do you agree that...								
you enjoy learning science?	2.58	0.84	1	4	2.94	0.87	1	4
you wish you did not have to study science?*	2.59	0.87	1	4	2.95	0.87	1	4
you read about science in your spare time?	1.43	0.65	1	4	1.72	0.80	1	4
science is boring?*	2.69	0.83	1	4	2.97	0.84	1	4
you learn many interesting things in science?	2.50	0.88	1	4	2.80	0.89	1	4
you like science?	2.37	0.93	1	4	2.78	0.94	1	4
it is important to do well in science?	2.89	0.88	1	4	3.14	0.85	1	4
Number of books at home	2.91	1.22	1	5	3.00	1.27	1	5
Possessions at home (a computer, a desk etc.)	7.82	1.57	1	11	7.83	1.72	2	11
Possessions at home11	0.03		0	1	0.05		0	1
Highest level of education completed by mother								
University, college, or Graduate school	0.45		0	1	0.38		0	1
Junior college	0.27		0	1	0.20		0	1
High school or below	0.37		0	1	0.35		0	1
Unknown	0.19		0	1	0.27		0	1
Highest level of education completed by father								
University, college, or Graduate school	0.39		0	1	0.39		0	1
Junior college	0.08		0	1	0.09		0	1
High school or below	0.32		0	1	0.29		0	1
Unknown	0.29		0	1	0.32		0	1
Children born between January 1 to April 1	0.23		0	1	0.25		0	1
Experiences of being bullied								
During this year, how often …								
were you made fun of or called names at school?	2.04	1.00	1	4	2.34	1.12	1	4
were you left out of games or activities by other students at school?	1.37	0.68	1	4	1.41	0.73	1	4
did someone spread lies about you at school?	1.43	0.71	1	4	1.65	0.87	1	4
was something stolen from you at school?	1.12	0.36	1	4	1.30	0.63	1	4
were you hit or hurt by other student(s) at school?	1.34	0.76	1	4	1.83	1.07	1	4
were you made to do things you didn't want to do by other students at school?	1.27	0.58	1	4	1.39	0.73	1	4
Total enrolment of students (in hundreds)	3.62	2.30	0.45	11.1	3.49	2.25	0.45	10.1
Location	2.33	0.97	1	4	2.23	0.94	1	4
Type of school	0.10		0	1	0.09		0	1
School-P	7.55	0.77	6.33	9.42	7.49	0.72	6.33	9.42
Income level of school's immediate area	1.85	0.58	1	3	1.80	0.57	1	3
Percentage of students from economically disadvantaged home	1.82	0.85	1	4	1.87	0.91	1	4
Class size	30.16	5.60	16	46	29.90	5.55	16	46

Note: *Answer categories are inversed

Table 3 Results for Factor Analysis

	Fourth grade		Eighth grade	
	Male	Female	Male	Female
	Factor1	Factor1	Factor1	Factor1
Attitudes toward Math				
How much do you agree that...				
you enjoy learning mathematics?	0.921	0.896	0.877	0.886
you wish you did not have to study mathematics?*	0.572	0.601	0.526	0.569
mathematics is boring?*	0.659	0.676	0.650	0.717
you learn many interesting things in mathematics?	0.707	0.687	0.789	0.750
you like mathematics?	0.907	0.901	0.907	0.876
it is important to do well in mathematics?	0.389	0.389	0.339	0.289
Attitudes toward Science				
How much do you agree that...				
you enjoy learning science?	0.843	0.872	0.881	0.874
you wish you did not have to study science?*	0.628	0.645	0.594	0.662
you read about science in your spare time?	0.428	0.402	0.477	0.453
science is boring?*	0.666	0.699	0.717	0.714
you learn many interesting things in science?	0.726	0.682	0.812	0.744
you like science?	0.882	0.892	0.901	0.874
it is important to do well in science?	0.529	0.432	0.470	0.396
Experiences of being bullied				
During this year, how often …				
were you made fun of or called names at school?	0.699	0.685	0.697	0.728
were you left out of games or activities by other students at school?	0.680	0.682	0.663	0.679
did someone spread lies about you at school?	0.671	0.643	0.670	0.642
was something stolen from you at school?	0.524	0.509	0.428	0.353
were you hit or hurt by other student(s) at school?	0.637	0.569	0.714	0.545
were you made to do things you didn't want to do by other students at school?	0.620	0.639	0.676	0.592

*Answer categories are inversed

Table 4 Results for Fourth Grade (Mathematics)

VARIABLES	Male				Female			
	Model 1		Model 2		Model 3		Model 4	
	Achievement	Attitude	Achievement	Attitude	Achievement	Attitude	Achievement	Attitude
Ask	-0.0447	0.0364			-2.771	0.0525*		
	(1.583)	(0.028)			(1.751)	(0.029)		
Talk	-4.801***	0.0871***			-3.450*	0.129***		
	(1.721)	(0.028)			(1.795)	(0.028)		
Time	-0.244	0.0436**			1.348	0.0356*		
	(1.358)	(0.021)			(1.379)	(0.020)		
Check	2.813**	-0.00816			3.100**	-0.0134		
	(1.398)	(0.021)			(1.388)	(0.021)		
Communicating			-3.665***	0.0924***			-4.620***	0.135***
			(1.192)	(0.021)			(1.318)	(0.023)
Monitoring			2.231*	0.0303*			3.835***	0.0182
			(1.287)	(0.018)			(1.297)	(0.020)
Mathematics attitude	20.15***		20.04***		17.82***		17.77***	
	(1.658)		(1.660)		(1.736)		(1.730)	
Possessions at home	4.049***	0.0574***	4.033***	0.0580***	3.697***	0.0508***	3.302***	0.0516***
	(1.174)	(0.015)	(1.176)	(0.015)	(0.994)	(0.015)	(0.919)	(0.015)
Possessions at home11	-15.29**		-15.49**		-7.295	-0.118		-0.119
	(6.148)		(6.112)		(5.754)	(0.109)		(0.111)
Number of books at home	14.21***	0.0308	14.28***	0.0299	13.79***	0.0786***	13.69***	0.0811***
	(1.607)	(0.026)	(1.626)	(0.026)	(1.746)	(0.026)	(1.733)	(0.026)
Children born between January 1 and April 1	-16.34***	0.0877*	-16.34***	0.0879*	-16.04***		-16.00***	
	(3.550)	(0.052)	(3.531)	(0.053)	(3.318)		(3.320)	
Experiences of being bullied		-0.0673***		-0.0700***		-0.149***		-0.149***
		(0.023)		(0.023)		(0.029)		(0.030)
Total enrolment of students (in hundreds)		0.0366**		0.0372**		-0.00837		
		(0.015)		(0.015)		(0.014)		
Location of school	4.491**	-0.0695*	5.121***	-0.0704*	3.780**		3.901**	
	(1.814)	(0.036)	(1.927)	(0.037)	(1.756)		(1.754)	
Income level of school area	16.33***	-0.115*	14.47***	-0.114	10.19***		10.22***	
	(3.305)	(0.069)	(3.455)	(0.069)	(3.304)		(3.291)	
Class size		-0.0183***		-0.0184***	0.629**		0.637**	
		(0.006)		(0.006)	(0.314)		(0.316)	
% of economically disadvantaged students		-0.0712	-2.491	-0.0710		-0.0730*		
		(0.057)	(2.847)	(0.058)		(0.039)		
Random intercept of school	1		1		1		1	
	(0)		(0)		(0)		(0)	
Constant	484.8***	0.00854	485.2***	0.415	484.3***	-1.145***	482.1***	-0.787***
	(13.090)	(0.297)	(13.310)	(0.313)	(14.420)	(0.144)	(12.970)	(0.138)
Observations	1849	1849	1849	1849	1884	1884	1884	1884

Robust standard errors in parentheses

Note: AIC for Model 1 = 71668, Model 2 = 71686, Model 3 = 72815, and Model 4 =72826.

Table 5 Results for Fourth Grade (Science)

VARIABLES	Male				Female			
	Model 5		Model 6		Model 7		Model 8	
	Achievement	Attitude	Achievement	Attitude	Achievement	Attitude	Achievement	Attitude
Ask	0.442	-0.00300			-0.545	-0.0332		
	(1.458)	(0.026)			(1.471)	(0.026)		
Talk	-3.904***	0.0631**			-3.800***	0.0886***		
	(1.507)	(0.027)			(1.457)	(0.025)		
Time	1.642	0.0525**			2.652**	0.0167		
	(1.148)	(0.022)			(1.163)	(0.020)		
Check	0.988	0.0295			0.889	0.0419**		
	(1.205)	(0.021)			(1.255)	(0.021)		
Communicating			-2.444**	0.0448**			-3.105***	0.0394*
			(1.087)	(0.020)			(1.100)	(0.022)
Monitoring			2.321**	0.0700***			3.087***	0.0490**
			(1.153)	(0.020)			(1.194)	(0.020)
Science attitude	6.105***		6.037***		7.266***		7.142***	
	(1.271)		(1.290)		(1.288)		(1.307)	
Possessions at home	3.422***	0.0479***	3.437***	0.0479***	2.875***	0.0265*	2.950***	0.0241*
	(0.980)	(0.016)	(0.983)	(0.016)	(0.851)	(0.014)	(0.836)	(0.014)
Possessions at home11	-13.67**	-0.0927	-13.68**	-0.0910		0.197**		0.203**
	(5.713)	(0.099)	(5.643)	(0.099)		(0.091)		(0.091)
Number of books at home	14.96***	0.0442*	14.95***	0.0433*	13.59***	0.0606***	13.60***	0.0614***
	(1.442)	(0.024)	(1.443)	(0.024)	(1.418)	(0.020)	(1.418)	(0.020)
Children born between January 1 and April 1	-22.30***	0.112**	-22.35***	0.113**	-21.53***	0.0673	-21.51***	0.0657
	(3.007)	(0.051)	(3.007)	(0.051)	(2.732)	(0.052)	(2.730)	(0.052)
Experiences of being bullied		-0.0215		-0.0238		-0.0801**		-0.0804**
		(0.023)		(0.023)		(0.033)		(0.032)
Total enrolment of students (in hundreds)		0.0302**		0.0305**		0.0197		0.0209
		(0.014)		(0.014)		(0.017)		(0.017)
Location of school			2.695					
			(1.647)					
Income level of school area	11.26***	-0.155***	10.72***	-0.155***	8.579***	-0.123	8.015***	-0.119
	(3.160)	(0.054)	(3.083)	(0.054)	(3.119)	(0.081)	(3.097)	(0.081)
Class size		-0.0146**		-0.0147**			0.444*	
		(0.006)		(0.006)			(0.259)	
% of economically disadvantaged students		-0.0976*		-0.0972*		-0.0440		-0.0405
		(0.057)		(0.057)		(0.044)		(0.044)
Random intercept of school	1		1		1		1	
	(0)		(0)		(0)		(0)	
Constant	483.3***	-0.0550	474.6***	0.321	491.5***	-0.640***	475.6***	-0.315
	(9.964)	(0.284)	(10.230)	(0.275)	(8.009)	(0.243)	(9.686)	(0.236)
Observations	1849	1849	1849	1849	1884	1884	1884	1884

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: AIC for Model 5 = 70166, Model 6 = 70176, Model 7 = 71672, and Model 8 =71696.

Table 6 Results for Eighth Grade (Male: Mathematics)

	Male							
	Model 9				Model 10			
VARIABLES	Achievement	Attitude	Aspiration	Ask	Achievement	Attitude	Aspiration	Communicating
Ask	2.752	-0.00888	0.110					
	(2.237)	(0.034)	(0.079)					
Talk	0.923	0.105***	0.237***					
	(2.524)	(0.030)	(0.071)					
Time	-1.531	0.0213	0.0750					
	(2.047)	(0.034)	(0.067)					
Check	-1.658	0.0655**	-0.0281					
	(1.812)	(0.030)	(0.074)					
Communicating					2.560	0.0655***	0.237***	
					(1.655)	(0.020)	(0.048)	
Monitoring					-2.675**	0.0710***	0.0408	
					(1.350)	(0.023)	(0.050)	
Mathematics attitude	24.97***				25.10***			
	(1.658)				(1.696)			
Aspiration	31.67***				31.83***			
	(2.190)				(2.185)			
Possessions at home	1.804	0.0920***	0.258***	0.254***	1.839	0.0903***	0.259***	0.172***
	(1.287)	(0.014)	(0.035)	(0.026)	(1.272)	(0.014)	(0.035)	(0.018)
Possessions at home11								
Number of books at home	6.414***		0.139***		6.402***		0.139***	
	(1.496)		(0.047)		(1.488)		(0.047)	
Ref: High school or below								
Mother: Higher than University			0.711***				0.687***	
			(0.217)				(0.216)	
Mother: Junior college	10.05**	0.0610	-0.255		10.04**	0.0609	-0.253	
	(4.511)	(0.055)	(0.215)		(4.528)	(0.055)	(0.215)	
Mother: Unknown	-8.589*		0.271		-8.559*		0.261	
	(4.775)		(0.165)		(4.795)		(0.167)	
Father: Higher than University		0.168***	1.129***			0.167***	1.143***	
		(0.064)	(0.182)			(0.065)	(0.184)	
Father: Junior college	-17.38***	-0.102	-0.758***		-17.42***	-0.106	-0.766***	
	(6.657)	(0.091)	(0.220)		(6.576)	(0.090)	(0.218)	
Father: Unknown	-5.145	0.109*	0.328*		-5.268	0.110*	0.334*	
	(4.519)	(0.060)	(0.175)		(4.523)	(0.060)	(0.179)	
Children born between January 1 and April 1	-13.70***				-13.43***		-0.112	
	(4.419)				(4.437)		(0.117)	
Experiences of being bullied		0.0348				0.0361		
		(0.029)				(0.029)		
Total enrolment of students (in hundreds)		-0.0190				-0.0170	-0.0202	
		(0.017)				(0.017)	(0.029)	
Location of school	5.741*	0.0334	0.159*		5.773*		0.170**	
	(3.165)	(0.037)	(0.083)		(3.316)		(0.084)	
Private or national school	36.16***	0.197**	0.896***		33.84***	0.212**	0.854***	
	(12.870)	(0.098)	(0.200)		(11.490)	(0.093)	(0.212)	
School-P	12.03**		0.146		15.09**		0.151	
	(5.382)		(0.107)		(6.346)		(0.108)	
Income level of school area		0.104	0.134		-4.347	0.0990	0.150	
		(0.080)	(0.114)		(5.847)	(0.079)	(0.120)	
% of economically disadvantaged students		0.0373				0.0417		
		(0.056)				(0.057)		
Class size		-0.0106	-0.0201		-0.360	-0.0100	-0.0170	
		(0.007)	(0.013)		(0.662)	(0.007)	(0.013)	
Random intercept of school	1				1			
	(0)				(0)			
Constant	361.9***	-1.188***			360.5***	-0.700**		-1.402***
	(40.780)	(0.368)			(45.910)	(0.345)		(0.144)
Observations	1789	1789	1789	1789	1789	1789	1789	1789

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: AIC for Model 9 = 164053 and Model 10 = 169972.

Table 7 Results for Eighth Grade (Female: Mathematics)

	Female					
	Model 11			Model 12		
VARIABLES	Achievement	Attitude	Aspiration	Achievement	Attitude	Aspiration
Ask	-3.892*	0.00992	0.0217			
	(2.116)	(0.035)	(0.069)			
Talk	2.127	0.159***	0.134*			
	(2.267)	(0.036)	(0.074)			
Time	2.731	0.00161	0.0830			
	(2.158)	(0.029)	(0.063)			
Check	-4.237**	-0.00145	-0.0987			
	(1.958)	(0.028)	(0.064)			
Communicating				-1.146	0.114***	0.111**
				(1.128)	(0.025)	(0.044)
Monitoring				-1.488	-0.00167	-0.0189
				(1.223)	(0.021)	(0.047)
Mathematics attitude	25.26***			25.42***		
	(1.485)			(1.510)		
Aspiration	29.20***			29.42***		
	(2.213)			(2.249)		
Possessions at home	4.751***	0.0765***	0.237***	4.822***	0.0761***	0.240***
	(1.162)	(0.014)	(0.033)	(1.172)	(0.014)	(0.033)
Possessions at home11			-0.501			-0.504
			(0.398)			(0.396)
Number of books at home	9.558***	0.0398*	0.155***	9.473***	0.0412*	0.151***
	(1.419)	(0.022)	(0.050)	(1.426)	(0.022)	(0.050)
Ref: High school or below						
Mother: Higher than University		0.125*	1.318***		0.137*	1.316***
		(0.069)	(0.229)		(0.073)	(0.228)
Mother: Junior college	5.454	-0.0799	-1.025***	5.415	-0.0862	-1.023***
	(3.761)	(0.077)	(0.219)	(3.791)	(0.077)	(0.217)
Mother: Unknown		0.131*	0.551***		0.152**	0.542***
		(0.068)	(0.193)		(0.076)	(0.192)
Father: Higher than University	14.55***	0.127*	1.109***	13.47***	0.106	1.112***
	(4.053)	(0.072)	(0.155)	(4.469)	(0.085)	(0.155)
Father: Junior college	-18.20***	0.147	-0.706***	-18.08***	0.152	-0.705***
	(5.397)	(0.107)	(0.207)	(5.426)	(0.106)	(0.208)
Father: Unknown			0.258	-2.423	-0.0480	0.255
			(0.174)	(4.141)	(0.078)	(0.172)
Children born between January 1 and April 1	-7.486*		-0.263**	-7.310*		-0.262**
	(3.902)		(0.118)	(3.923)		(0.119)
Experiences of being bullied		-0.0191			-0.0204	
		(0.030)			(0.031)	
Total enrolment of students (in hundreds)	1.519			1.583		
	(1.404)			(1.404)		
Location of school						
Private or national school	8.784		1.576***	8.864		1.573***
	(12.070)		(0.262)	(12.340)		(0.267)
School-P		-0.0653	0.167		-0.0673	0.167
		(0.042)	(0.114)		(0.042)	(0.114)
Income level of school area	14.77***		0.357**	14.42***		0.351**
	(4.829)		(0.141)	(5.066)		(0.143)
% of economically disadvantaged students			0.0869			0.0869
			(0.101)			(0.101)
Class size	0.463	-0.00757	-0.0174	0.454	-0.00800	-0.0174
	(0.847)	(0.008)	(0.016)	(0.854)	(0.008)	(0.016)
Random intercept of school	1			1		
	(0)			(0)		
Constant	382.9***	-0.546*		376.8***	-0.0750	
	(29.560)	(0.316)		(29.460)	(0.289)	
Observations	1812	1812	1812	1812	1812	1812

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: AIC for Model 11 =142262 and Model12=142348.

Table 8 Results for Eighth Grade (Male: Science)

	Male					
	Model 13			Model 14		
VARIABLES	Achievement	Attitude	Aspiration	Achievement	Attitude	Aspiration
Ask	1.052	0.0115	0.108			
	(2.255)	(0.033)	(0.079)			
Talk	-0.335	0.127***	0.233***			
	(2.171)	(0.034)	(0.071)			
Time	0.0919	0.0387	0.0744			
	(1.840)	(0.030)	(0.067)			
Check	0.133	0.00455	-0.0245			
	(1.837)	(0.029)	(0.076)			
Communicating				0.546	0.0945***	0.237***
				(1.461)	(0.022)	(0.048)
Monitoring				0.278	0.0357	0.0408
				(1.270)	(0.022)	(0.050)
Science attitude	22.91***			22.90***		
	(1.816)			(1.822)		
Aspiration	27.08***			27.01***		
	(1.927)			(1.910)		
Possessions at home	1.239	0.0425**	0.258***	1.628	0.0457***	0.259***
	(1.206)	(0.018)	(0.035)	(1.198)	(0.017)	(0.035)
Possessions at home11	7.070	0.114			0.101	
	(9.471)	(0.166)			(0.169)	
Number of books at home	8.774***	0.0472**	0.139***	8.780***	0.0486**	0.139***
	(1.311)	(0.020)	(0.047)	(1.301)	(0.021)	(0.047)
Ref: High school or below						
Mother: Higher than University			0.709***			0.687***
			(0.217)			(0.216)
Mother: Junior college	10.94***	0.0790	-0.259	10.81***	0.0667	-0.253
	(4.047)	(0.059)	(0.215)	(4.116)	(0.059)	(0.215)
Mother: Unknown	-9.894***		0.270	-9.880***		0.261
	(3.692)		(0.165)	(3.719)		(0.167)
Father: Higher than University		0.102*	1.135***		0.128**	1.143***
		(0.060)	(0.184)		(0.060)	(0.184)
Father: Junior college	-4.733		-0.754***	-4.442		-0.766***
	(5.669)		(0.219)	(5.553)		(0.218)
Father: Unknown		0.0761	0.338*		0.0860	0.334*
		(0.058)	(0.177)		(0.058)	(0.179)
Children born between January 1and April 1	-10.78***	0.0583	-0.103	-10.80***	0.0556	-0.112
	(3.587)	(0.049)	(0.120)	(3.614)	(0.049)	(0.117)
Experiences of being bullied						
Total enrolment of students (in hundreds)		-0.0199		-1.120	-0.0156	-0.0202
		(0.019)		(1.155)	(0.020)	(0.029)
Location of school	4.778**	-0.0419	0.157*	5.216**		0.170**
	(2.363)	(0.043)	(0.083)	(2.391)		(0.084)
Private or national school	15.42	0.0976	0.897***	12.27	0.206*	0.854***
	(12.350)	(0.092)	(0.202)	(12.640)	(0.122)	(0.212)
School-P	14.90***		0.147	16.00***	-0.100*	0.151
	(3.988)		(0.108)	(4.121)	(0.055)	(0.108)
Income level of school area			0.133			0.150
			(0.115)			(0.120)
% of economically disadvantaged students					-0.00905	-0.0170
					(0.008)	(0.013)
Class size		-0.00763	-0.0200			
		(0.009)	(0.013)			
Random intercept of school	1			1		
	(0)			(0)		
Constant	335.5***	-0.553**		333.2***	0.508	
	(32.470)	(0.274)		(31.810)	(0.487)	
Observations	1789	1789	1789	1789	1789	1789

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: AIC for Model 13 = 139422 and Model 14 =139405.

Table 9 Results for Eighth Grade (Female: Science)

	Female							
	Model 15				Model 16			
VARIABLES	Achievement	Attitude	Aspiration	Talk	Achievement	Attitude	Aspiration	Communicating
Ask	-3.302*	-0.0565*	0.0192					
	(1.867)	(0.031)	(0.069)					
Talk	0.347	0.177***	0.134*					
	(2.112)	(0.034)	(0.074)					
Time	3.223*	0.0185	0.0829					
	(1.903)	(0.029)	(0.063)					
Check	-2.427*	0.0625**	-0.0963					
	(1.432)	(0.027)	(0.064)					
Communicating					-1.999*	0.0782***	0.111**	
					(1.212)	(0.021)	(0.044)	
Monitoring					0.359	0.0663***	-0.0189	
					(1.210)	(0.018)	(0.047)	
Science attitude	19.57***				19.83***			
	(1.514)				(1.480)			
Aspiration	28.67***				28.73***			
	(2.169)				(2.140)			
Possessions at home	4.077***	0.0194	0.236***	0.217***	4.162***	0.0164	0.240***	0.158***
	(1.108)	(0.017)	(0.033)	(0.031)	(1.110)	(0.018)	(0.033)	(0.022)
Possessions at home11			-0.516				-0.504	
			(0.397)				(0.396)	
Number of books at home	9.399***	0.119***	0.159***		9.328***	0.125***	0.151***	
	(1.344)	(0.022)	(0.050)		(1.339)	(0.022)	(0.050)	
Ref: High school or below								
Mother: Higher than University	2.931	0.0754	1.347***		2.927	0.0905*	1.316***	
	(4.472)	(0.055)	(0.228)		(4.483)	(0.054)	(0.228)	
Mother: Junior college	6.104		-1.037***		5.801		-1.023***	
	(4.049)		(0.218)		(4.057)		(0.217)	
Mother: Unknown		0.127	0.563***			0.140	0.542***	
		(0.083)	(0.195)			(0.086)	(0.192)	
Father: Higher than University	4.924		1.151***		5.384*		1.112***	
	(3.091)		(0.150)		(3.146)		(0.155)	
Father: Junior college			-0.735***				-0.705***	
			(0.204)				(0.208)	
Father: Unknown		-0.0474	0.280			-0.0651	0.255	
		(0.066)	(0.172)			(0.067)	(0.172)	
Children born between January 1and April 1	-2.973	-0.0809	-0.263**		-2.761	-0.0764	-0.262**	
	(3.199)	(0.051)	(0.119)		(3.198)	(0.052)	(0.119)	
Experiences of being bullied								
Total enrolment of students (in hundreds)					0.669			
					(1.050)			
Location of school		-0.103***						
		(0.038)						
Private or national school			1.700***			-0.120	1.573***	
			(0.251)			(0.141)	(0.267)	
School-P						-0.0774	0.167	
						(0.0620)	(0.114)	
Income level of school area	13.22***	0.0563	0.433***		10.62***	0.0964	0.351**	
	(3.827)	(0.074)	(0.141)		(3.692)	(0.081)	(0.143)	
% of economically disadvantaged students		0.0719	0.0727			0.0423	0.0869	
		(0.061)	(0.101)			(0.062)	(0.101)	
Class size			-0.0137				-0.0174	
			(0.015)				(0.016)	
Random intercept of school	1				1			
	(0)				(0)			
Constant	403.2***	-0.997***			398.1***	-0.190		-1.039***
	(10.280)	(0.298)			(11.770)	(0.506)		(0.177)
Observations	1812	1812	1812	1812	1812	1812	1812	1812

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: AIC for Model 15 = 164742 and Model 16 =171096.

Appendix

Table A. 1 Correlation for the Variables of Parental Involvement

Fourth grade males

	Ask	Talk	Time	Check
Ask	1			
Talk	0.5223	1		
Time	0.3772	0.3331	1	
Check	0.279	0.2938	0.4266	1

	Communicating	Monitoring
Communicating	1	
Monitoring	0.4357	1

Fourth grade females

	Ask	Talk	Time	Check
Ask	1			
Talk	0.5489	1		
Time	0.3787	0.3519	1	
Check	0.293	0.2895	0.4925	1

	Communicating	Monitoring
Communicating	1	
Monitoring	0.4317	1

Eighth grade males

	Ask	Talk	Time	Check
Ask	1			
Talk	0.5969	1		
Time	0.3662	0.3836	1	
Check	0.3454	0.3437	0.6698	1

	Communicating	Monitoring
Communicating	1	
Monitoring	0.4406	1

Eighth grade females

	Ask	Talk	Time	Check
Ask	1			
Talk	0.6248	1		
Time	0.4156	0.3844	1	
Check	0.3566	0.3365	0.7309	1

	Communicating	Monitoring
Communicating	1	
Monitoring	0.4454	1

Table A. 2 The Paths of the Parental Involvement that Changed Significance When Estimating Models with All the Variables

Variables	Significance of the final model	Significance of the model with all variables
4th Male		
Check → Mathematics achievement (+)	5%	10%
8th Male		
Monitoring → Science achievement (-)	10%	5%

Note: The table shows the paths of parental involvement that had changes at the level which they are significant. Except for the two paths shown in the table above, results of estimations using all the control variables did not differ from the final results. Estimation results are presented in Appendix from Table A.3 to Table A.10. In the cases that full model estimations failed to converge, some variables had to be dropped.

Table A. 3 Results for Fourth Grade with All the Control Variables (Male: Mathematics)

VARIABLES	Male									
	Model 1a						Model 2a			
	Achievement	Attitude	Ask	Time	Check	Talk	Achievement	Attitude	Communicating	Monitoring
Ask	0.360	0.0365								
	(1.602)	(0.028)								
Talk	-4.951***	0.0872***								
	(1.697)	(0.028)								
Time	-0.156	0.0437**								
	(1.374)	(0.021)								
Check	2.551*	-0.00850								
	(1.419)	(0.021)								
Communicating							-3.634***	0.0926***		
							(1.188)	(0.021)		
Monitoring							2.149*	0.0301*		
							(1.281)	(0.018)		
Mathematics attitude	19.47***						19.92***			
	(1.709)						(1.652)			
Possessions at home	4.296***	0.0599***	0.213***	0.138***	0.0956***	0.188***	4.026***	0.0603***	0.157***	0.0853***
	(1.176)	(0.016)	(0.030)	(0.028)	(0.033)	(0.028)	(1.174)	(0.017)	(0.019)	(0.019)
Possessions at home11	-14.85**	-0.0389	0.115	0.00326	-0.261	0.124	-14.81**	-0.0350	0.0577	-0.0954
	(6.177)	(0.094)	(0.207)	(0.227)	(0.203)	(0.171)	(6.113)	(0.094)	(0.106)	(0.130)
Number of books at home	14.34***	0.0312	0.109**	0.122***	0.122**	0.0735	14.30***	0.0303	0.0668**	0.0901***
	(1.617)	(0.026)	(0.045)	(0.046)	(0.049)	(0.051)	(1.623)	(0.026)	(0.030)	(0.029)
Children born between January 1 and April 1	-16.68***	0.0879*					-16.29***	0.0880*		
	(3.530)	(0.052)					(3.518)	(0.053)		
Experiences of being bullied		-0.0672***						-0.0699***		
		(0.023)						(0.023)		
Total enrolment of students (in hundreds)	-0.0142	0.0367**					0.466	0.0373**		
	(1.312)	(0.015)					(0.789)	(0.015)		
Location of school	2.942	-0.0695*					3.836*	-0.0704*		
	(2.443)	(0.036)					(2.033)	(0.037)		
Income level of school area	12.16***	-0.115*					11.23***	-0.114		
	(4.349)	(0.069)					(4.150)	(0.069)		
Class size	0.365	-0.0183***					0.130	-0.0184***		
	(0.514)	(0.006)					(0.390)	(0.006)		
% of economically disadvantaged students	0.302	-0.0715					-2.496	-0.0713		
	(3.154)	(0.057)					(2.666)	(0.058)		
Random intercept of school	1						1			
	(0)						(0)			
Constant	483.3***	-0.0113					487.9***	0.397	-1.602***	-0.921***
	(20.570)	(0.299)					(14.270)	(0.313)	(0.144)	(0.131)
Observations	1849	1849	1849	1849	1849	1849	1849	1849	1849	1849

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: AIC for Model 1a = 126356 and for Model 2a = 105220.

Table A. 4 Results for Fourth Grade with All the Control Variables (Female: Mathematics)

VARIABLES	Female							
	Model 3a						Model 4a	
	Achievement	Attitude	Ask	Time	Check	Talk	Achievement	Attitude
Ask	-3.143*	0.0532*						
	(1.747)	(0.029)						
Talk	-3.204*	0.128***						
	(1.776)	(0.028)						
Time	1.527	0.0348*						
	(1.431)	(0.020)						
Check	2.913**	-0.0127						
	(1.375)	(0.021)						
Communicating							-4.605***	0.134***
							(1.317)	(0.023)
Monitoring							3.840***	0.0179
							(1.294)	(0.019)
Mathematics attitude	17.33***						17.75***	
	(1.724)						(1.738)	
Possessions at home	3.685***	0.0509***	0.189***	0.149***	0.104***	0.124***	3.689***	0.0503***
	(0.971)	(0.015)	(0.030)	(0.029)	(0.033)	(0.029)	(0.992)	(0.015)
Possessions at home11	-5.999	-0.120	0.106	0.367	0.0436	0.466**	-7.526	-0.110
	(5.667)	(0.110)	(0.229)	(0.240)	(0.233)	(0.219)	(5.774)	(0.110)
Number of books at home	13.96***	0.0788***	0.0893*	0.172***	0.124**	0.130***	13.74***	0.0805***
	(1.734)	(0.026)	(0.051)	(0.051)	(0.050)	(0.049)	(1.745)	(0.026)
Children born between January 1 and April 1	-16.25***	-0.00451					-16.04***	-0.00666
	(3.352)	(0.045)					(3.326)	(0.046)
Experiences of being bullied		-0.149***						-0.150***
		(0.029)						(0.029)
Total enrolment of students (in hundreds)	-0.469	-0.00683					1.184	-0.00595
	(0.953)	(0.017)					(0.866)	(0.017)
Location of school	2.119	-0.0101					2.738	-0.0143
	(2.674)	(0.036)					(1.989)	(0.035)
Income level of school area	12.93**	0.00907					10.23***	0.0125
	(6.527)	(0.066)					(3.796)	(0.065)
Class size	0.903**	-0.00139					0.463	-0.00207
	(0.453)	(0.007)					(0.329)	(0.007)
% of economically disadvantaged students	4.291	-0.0682					1.529	-0.0631
	(4.461)	(0.045)					(2.618)	(0.045)
Random intercept of school	1						1	
	(0)						(0)	
Constant	470.8***	-1.113***					478.3***	-0.563**
	(21.070)	(0.267)					(16.000)	(0.264)
Observations	1,884	1,884	1,884	1,884	1,884	1,884	1,884	1,884

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: AIC for Model 3a = 128190 and for Model 4a = 72832.

Table A. 5 Results for Fourth Grade with All the Control Variables (Male: Science)

VARIABLES	Male									
	Model 5a						Model 6a			
	Achievement	Attitude	Ask	Time	Check	Talk	Achievement	Attitude	Communicating	Monitoring
Ask	0.674	-0.00324								
	(1.466)	(0.026)								
Talk	-4.268***	0.0634**								
	(1.493)	(0.027)								
Time	1.824	0.0526**								
	(1.148)	(0.022)								
Check	0.756	0.0296								
	(1.201)	(0.021)								
Communicating							-2.422**	0.0447**		
							(1.078)	(0.020)		
Monitoring							2.248**	0.0701***		
							(1.147)	(0.021)		
Science attitude	5.810***						5.941***			
	(1.288)						(1.295)			
Possessions at home	3.588***	0.0478***	0.213***	0.138***	0.0956***	0.188***	3.455***	0.0478***	0.157***	0.0853***
	(0.973)	(0.016)	(0.030)	(0.028)	(0.033)	(0.028)	(0.981)	(0.016)	(0.019)	(0.019)
Possessions at home11	-13.37**	-0.0927	0.115	0.00328	-0.261	0.124	-13.27**	-0.0910	0.0577	-0.0954
	(5.782)	(0.099)	(0.207)	(0.227)	(0.203)	(0.171)	(5.654)	(0.099)	(0.106)	(0.130)
Number of books at home	14.85***	0.0438*	0.109**	0.122***	0.122**	0.0735	14.89***	0.0430*	0.0668**	0.0901***
	(1.441)	(0.024)	(0.045)	(0.046)	(0.049)	(0.051)	(1.441)	(0.024)	(0.030)	(0.029)
Children born between January 1 and April 1	-22.20***	0.112**					-22.19***	0.113**		
	(2.998)	(0.051)					(3.007)	(0.051)		
Experiences of being bullied		-0.0215						-0.0238		
		(0.023)						(0.023)		
Total enrolment of students (in hundreds)	0.217	0.0293**					0.825	0.0298**		
	(0.991)	(0.014)					(0.681)	(0.014)		
Location of school	1.882	0.00792					2.235	0.00655		
	(1.904)	(0.031)					(1.736)	(0.031)		
Income level of school area	10.08***	-0.158***					7.080**	-0.157***		
	(3.428)	(0.057)					(3.352)	(0.056)		
Class size	-0.0417	-0.0144**					-0.183	-0.0146**		
	(0.395)	(0.006)					(0.302)	(0.007)		
% of economically disadvantaged students	-0.0776	-0.100*					-3.505	-0.0994*		
	(2.309)	(0.059)					(2.142)	(0.059)		
Random intercept of school	1						1			
	(0)						(0)			
Constant	480.3***	-0.0623					488.8***	0.315	-1.602***	-0.921***
	(14.230)	(0.281)					(11.920)	(0.273)	(0.144)	(0.131)
Observations	1849	1849	1849	1849	1849	1849	1849	1849	1849	1849

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: AIC for Model 5a = 234199 and for Model 6a = 199969.

Table A. 6 Results for Fourth Grade with All the Control Variables (Female: Science)

VARIABLES	Female								
	Model 7a						Model 8a		
	Achievement	Attitude	Ask	Time	Check	Talk	Achievement	Attitude	Communicating
Ask	-0.899	-0.0326							
	(1.474)	(0.026)							
Talk	-3.518**	0.0879***							
	(1.462)	(0.025)							
Time	2.859**	0.0164							
	(1.203)	(0.020)							
Check	0.699	0.0420**							
	(1.238)	(0.020)							
Communicating							-3.184***	0.0392*	
							(1.101)	(0.022)	
Monitoring							3.206***	0.0488**	
							(1.187)	(0.020)	
Science attitude	6.820***						6.986***		
	(1.245)						(1.305)		
Possessions at home	2.998***	0.0267*	0.195***	0.168***	0.106***	0.147***	3.066***	0.0244*	0.145***
	(0.886)	(0.014)	(0.028)	(0.029)	(0.029)	(0.028)	(0.884)	(0.014)	(0.016)
Possessions at home11	-1.309	0.196**					-2.096	0.202**	
	(5.137)	(0.091)					(5.310)	(0.091)	
Number of books at home	13.77***	0.0604***	0.0906*	0.176***	0.125**	0.133***	13.62***	0.0612***	
	(1.436)	(0.021)	(0.050)	(0.052)	(0.050)	(0.049)	(1.422)	(0.021)	
Children born between January 1 and April 1	-21.68***	0.0670					-21.73***	0.0653	
	(2.751)	(0.051)					(2.750)	(0.052)	
Experiences of being bullied		-0.0799**						-0.0801**	
		(0.033)						(0.033)	
Total enrolment of students (in hundreds)	-0.637	0.0211					-0.671	0.0227	
	(0.792)	(0.019)					(1.114)	(0.019)	
Location of school	2.459	-0.000224					2.672	3.19e-05	
	(2.135)	(0.037)					(1.868)	(0.038)	
Income level of school area	8.256	-0.123					6.137*	-0.120	
	(5.134)	(0.085)					(3.566)	(0.085)	
Class size	0.410	-0.00232					0.591*	-0.00306	
	(0.330)	(0.007)					(0.331)	(0.007)	
% of economically disadvantaged students	-0.382	-0.0447					-2.654	-0.0416	
	(3.812)	(0.045)					(2.406)	(0.045)	
Random intercept of school	1						1		
	(0)						(0)		
Constant	476.6***	-0.578*					474.6***	-0.234	-0.987***
	(16.560)	(0.338)					(12.640)	(0.323)	(0.140)
	1,884	1,884	1,884	1,884	1,884	1,884	1,884	1,884	1,884

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: AIC for Model 7a = 238375 and for Model 8a = 204006.

Table A. 7 Results for Eighth Grade with All the Control Variables (Male: Mathematics)

	Male												
	Model 9a							Model 10a					
VARIABLES	Achievement	Attitude	Aspiration	Ask	Time	Check	Talk	Achievement	Attitude	Aspiration	Communicating	Monitoring	
Ask	2.571	-0.00819	0.108										
	(2.259)	(0.035)	(0.079)										
Talk	1.280	0.104***	0.233***										
	(2.525)	(0.030)	(0.070)										
Time	-1.221	0.0208	0.0798										
	(2.012)	(0.033)	(0.068)										
Check	-1.821	0.0665**	-0.0272										
	(1.834)	(0.030)	(0.076)										
Communicating								2.605	0.0650***	0.236***			
								(1.668)	(0.021)	(0.048)			
Monitoring								-2.319*	0.0722***	0.0405			
								(1.333)	(0.023)	(0.050)			
Mathematics attitude	25.04***							24.97***					
	(1.623)							(1.652)					
Aspiration	31.32***							31.30***					
	(2.331)							(2.294)					
Possessions at home	1.864	0.0935***	0.250***	0.144***	0.153***	0.142***	0.0599	2.023*	0.0922***	0.252***	0.107***	0.0654**	
	(1.243)	(0.016)	(0.037)	(0.037)	(0.036)	(0.035)	(0.041)	(1.228)	(0.015)	(0.036)	(0.023)	(0.028)	
Possessions at home11	-0.629	-0.0199	0.184	0.0543	0.290	-0.152	0.213	-1.001	-0.0210	0.160	0.145	0.0769	
	(10.720)	(0.140)	(0.372)	(0.220)	(0.253)	(0.234)	(0.294)	(10.940)	(0.139)	(0.374)	(0.140)	(0.186)	
Number of books at home	6.975***	0.000751	0.139***	0.135***	0.165***	0.150***	0.0987***	7.064***	-0.000863	0.139***	0.107***	0.0989***	
	(1.577)	(0.021)	(0.047)	(0.048)	(0.045)	(0.040)	(0.038)	(1.558)	(0.021)	(0.047)	(0.031)	(0.026)	
Ref: High school or below													
Mother: Higher than University	0.607	-0.00496	0.707***	-0.0666	0.295**	0.241*	0.403***	0.744	-0.0125	0.687***	0.0754	0.227**	
	(5.476)	(0.081)	(0.218)	(0.144)	(0.144)	(0.135)	(0.153)	(5.365)	(0.080)	(0.217)	(0.094)	(0.102)	
Mother: Junior college	10.11*	0.0635	-0.256	0.132	0.0380	-0.0717	-0.0804	9.806*	0.0649	-0.251	0.0692	-0.0363	
	(5.699)	(0.078)	(0.216)	(0.150)	(0.150)	(0.165)	(0.163)	(5.680)	(0.078)	(0.216)	(0.100)	(0.117)	
Mother: Unknown	-8.892*	0.00324	0.268	-0.310*	-0.0343	0.417**	0.333**	-8.630*	-0.00535	0.260	-0.140	0.283***	
	(4.825)	(0.085)	(0.165)	(0.159)	(0.146)	(0.168)	(0.156)	(4.837)	(0.085)	(0.167)	(0.099)	(0.107)	
Father: Higher than University	0.545	0.176**	1.143***	0.240*	0.212	-0.0120	0.0419	-18.31**	-0.108	-0.775***	-0.142	0.00708	
	(4.679)	(0.073)	(0.186)	(0.133)	(0.135)	(0.137)	(0.126)	(7.270)	(0.093)	(0.222)	(0.142)	(0.136)	
Father: Junior college	-19.18***	-0.105	-0.768***	-0.247	-0.0762	-0.0455	0.0946	0.510	0.179**	1.145***	0.178**	0.0351	
	(7.363)	(0.094)	(0.224)	(0.189)	(0.237)	(0.206)	(0.201)	(4.672)	(0.073)	(0.185)	(0.091)	(0.090)	
Father: Unknown	-5.267	0.111	0.339*	-0.0696	-0.163	-0.448***	-0.177	-5.115	0.117	0.336*	-0.0788	-0.220**	
	(4.838)	(0.075)	(0.177)	(0.154)	(0.153)	(0.161)	(0.137)	(4.835)	(0.075)	(0.179)	(0.102)	(0.098)	
Children born between January 1 and April 1	-14.37***	-0.0129	-0.107					-13.78***	-0.0143	-0.114			
	(4.330)	(0.048)	(0.119)					(4.372)	(0.049)	(0.117)			
Experiences of being bullied		0.0346							0.0348				
		(0.029)							(0.029)				
Total enrolment of students (in hundreds)	-0.856	-0.0182	-0.0211					-1.341	-0.0187	-0.0202			
	(1.305)	(0.017)	(0.029)					(1.299)	(0.017)	(0.029)			
Location of school	4.249	0.0355	0.165*					5.023	0.0385	0.170**			
	(3.422)	(0.037)	(0.086)					(3.425)	(0.037)	(0.085)			
Private or national school	36.96***	0.221*	0.834***					32.75***	0.227**	0.846***			
	(9.954)	(0.113)	(0.231)					(11.710)	(0.111)	(0.228)			
School-P	11.30**	-0.0247	0.153					14.72**	-0.0279	0.148			
	(5.360)	(0.053)	(0.106)					(6.016)	(0.053)	(0.105)			
Income level of school area	3.195	0.113	0.140					-0.0348	0.116	0.144			
	(4.744)	(0.085)	(0.141)					(5.340)	(0.086)	(0.140)			
% of economically disadvantaged students	1.554	0.0345	-0.0157					0.682	0.0357	-0.0130			
	(3.941)	(0.056)	(0.103)					(3.910)	(0.056)	(0.102)			
Class size	-0.377	-0.0106	-0.0166					-0.191	-0.0113	-0.0170			
	(0.648)	(0.007)	(0.013)					(0.695)	(0.007)	(0.013)			
Random intercept of school	1							1					
	(0)							(0)					
Constant	378.0***	-1.035**						356.1***	-0.564		-1.269***	-0.853***	
	(45.310)	(0.468)						(49.280)	(0.473)		(0.163)	(0.196)	
	1,789	1,789	1,789	1,789	1,789	1,789	1,789	1,789	1,789	1,789	1,789	1,789	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: AIC for Model 9a = 124803 and for Model 10a = 103708.

Table A. 8 Results for Eighth Grade with All the Control Variables (Female: Mathematics)

	Female												
	Model 11a							Model 12a					
VARIABLES	Achievement	Attitude	Aspiration	Ask	Time	Check	Talk	Achievement	Attitude	Aspiration	Communicating	Monitoring
Ask	-3.226	0.00832	0.0212									
	(2.142)	(0.035)	(0.070)									
Talk	2.050	0.159***	0.133*									
	(2.247)	(0.036)	(0.073)									
Time	2.494	0.00279	0.0813									
	(2.101)	(0.028)	(0.064)									
Check	-4.586**	-0.000645	-0.0964									
	(1.931)	(0.027)	(0.065)									
Communicating								-0.732	0.113***	0.110**		
								(1.182)	(0.025)	(0.044)		
Monitoring								-1.842	-0.000335	-0.0182		
								(1.236)	(0.021)	(0.047)		
Mathematics attitude	24.93***							25.28***				
	(1.508)							(1.535)				
Aspiration	28.96***							29.23***				
	(2.218)							(2.234)				
Possessions at home	4.800***	0.0762***	0.238***	0.157***	0.170***	0.157***	0.0652*	4.801***	0.0770***	0.241***	0.118***	0.0789***
	(1.301)	(0.015)	(0.033)	(0.040)	(0.044)	(0.041)	(0.038)	(1.310)	(0.015)	(0.033)	(0.027)	(0.027)
Possessions at home11	4.006	-0.0582	-0.501	-0.160	-0.209	-0.0203	0.163	2.936	-0.0582	-0.504	-0.118	0.0858
	(7.849)	(0.145)	(0.399)	(0.288)	(0.240)	(0.309)	(0.304)	(7.915)	(0.147)	(0.397)	(0.173)	(0.226)
Number of books at home	10.09***	0.0415*	0.155***	0.143***	0.102**	0.0534	0.0977**	9.650***	0.0421*	0.151***	0.0857***	0.0613**
	(1.439)	(0.023)	(0.050)	(0.038)	(0.042)	(0.043)	(0.043)	(1.419)	(0.023)	(0.050)	(0.025)	(0.029)
Ref: High school or below												
Mother: Higher than University	0.924	0.127*	1.322***	0.177	0.153	0.0957	0.0742	1.508	0.132*	1.320***	0.114	0.0680
	(4.697)	(0.075)	(0.227)	(0.154)	(0.141)	(0.143)	(0.167)	(4.695)	(0.074)	(0.227)	(0.099)	(0.108)
Mother: Junior college	4.851	-0.0734	-1.030***	-0.217	-0.126	-0.173	-0.153	4.398	-0.0810	-1.028***	-0.108	-0.119
	(4.441)	(0.078)	(0.219)	(0.149)	(0.158)	(0.134)	(0.172)	(4.400)	(0.078)	(0.217)	(0.100)	(0.106)
Mother: Unknown	2.945	0.159**	0.549***	-0.449**	-0.352**	-0.0536	0.0823	2.892	0.155**	0.540***	-0.294**	0.00421
	(5.682)	(0.076)	(0.192)	(0.180)	(0.179)	(0.159)	(0.154)	(5.675)	(0.076)	(0.191)	(0.120)	(0.111)
Father: Higher than University	13.73***	0.112	1.112***	-0.00687	0.112	0.109	0.0539	13.38***	0.111	1.115***	0.0451	0.0609
	(4.737)	(0.087)	(0.157)	(0.115)	(0.123)	(0.135)	(0.135)	(4.754)	(0.086)	(0.157)	(0.077)	(0.097)
Father: Junior college	-17.06***	0.148	-0.705***	0.281	0.156	0.118	0.147	-16.46***	0.152	-0.704***	0.147	0.0906
	(5.410)	(0.108)	(0.207)	(0.176)	(0.188)	(0.176)	(0.178)	(5.419)	(0.107)	(0.208)	(0.121)	(0.130)
Father: Unknown	-2.040	-0.0401	0.262	-0.151	0.0755	-0.0537	-0.0720	-2.640	-0.0466	0.259	-0.0267	-0.0406
	(5.304)	(0.081)	(0.176)	(0.139)	(0.141)	(0.130)	(0.136)	(5.302)	(0.079)	(0.174)	(0.088)	(0.094)
Children born between January 1 and April 1	-7.164*	-0.0299	-0.268**					-7.033*	-0.0277	-0.267**		
	(3.949)	(0.057)	(0.119)					(4.006)	(0.057)	(0.119)		
Experiences of being bullied		-0.0195							-0.0197			
		(0.030)							(0.031)			
Total enrolment of students (in hundreds)	0.0557	-0.00194	0.0133					0.667	0.000167	0.0151		
	(1.279)	(0.014)	(0.034)					(1.316)	(0.014)	(0.034)		
Location of school	0.156	0.0168	-0.0391					-1.855		-0.0416		
	(2.947)	(0.039)	(0.076)					(3.056)		(0.076)		
Private or national school	17.27	0.0759	1.620***					13.80	0.0786	1.621***		
	(10.760)	(0.137)	(0.274)					(11.920)	(0.133)	(0.277)		
School-P	1.485	-0.0998**	0.170					1.577	-0.0973**	0.169		
	(3.535)	(0.050)	(0.118)					(3.871)	(0.047)	(0.118)		
Income level of school area	13.74***	0.0701	0.338**					13.36**	0.0605	0.331**		
	(5.265)	(0.076)	(0.148)					(5.698)	(0.075)	(0.150)		
% of economically disadvantaged students	4.791	0.0140	0.0911					4.263	0.0154	0.0912		
	(4.011)	(0.049)	(0.100)					(4.055)	(0.047)	(0.100)		
Class size	0.756	-0.0108	-0.0185					0.866	-0.0107	-0.0188		
	(0.773)	(0.010)	(0.018)					(0.811)	(0.010)	(0.018)		
Random intercept of school	1							1				
	(0)							(0)				
Constant	364.9***	-0.362						357.4***	0.0875		-0.961***	-0.795***
	(35.310)	(0.443)						(37.980)	(0.427)		(0.201)	(0.185)
Random intercept of school	1,812	1,812	1,812	1,812	1,812	1,812	1,812	1,812	1,812	1,812	1,812	1,812

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: AIC for Model 11a = 127038 and for Model 12a = 88858.

Table A. 9 Results for Eighth Grade with All the Control Variables (Male: Science)

	Male												
	Model 13a							Model 14a					
VARIABLES	Achievement	Attitude	Aspiration	Ask	Time	Check	Talk	Achievement	Attitude	Aspiration	Communicating	Monitoring
Ask	0.619	0.0140	0.108									
	(2.337)	(0.034)	(0.079)									
Talk	0.325	0.122***	0.233***									
	(2.253)	(0.035)	(0.070)									
Time	0.586	0.0390	0.0798									
	(1.811)	(0.030)	(0.068)									
Check	-0.133	0.00605	-0.0272									
	(1.804)	(0.029)	(0.076)									
Communicating								0.516	0.0935***	0.236***		
								(1.464)	(0.022)	(0.048)		
Monitoring								0.325	0.0367*	0.0405		
								(1.267)	(0.022)	(0.050)		
Science attitude	22.92***							23.02***				
	(1.706)							(1.727)				
Aspiration	26.78***							26.86***				
	(2.049)							(2.013)				
Possessions at home	1.187	0.0442**	0.250***	0.147***	0.168***	0.133***	0.0712*	1.321	0.0447***	0.252***	0.107***	0.0654**
	(1.175)	(0.017)	(0.037)	(0.033)	(0.033)	(0.032)	(0.037)	(1.164)	(0.017)	(0.036)	(0.023)	(0.028)
Possessions at home11	5.599	0.120	0.184					5.054	0.111	0.160	0.145	0.0769
	(9.800)	(0.165)	(0.372)					(9.989)	(0.166)	(0.374)	(0.140)	(0.186)
Number of books at home	8.969***	0.0503**	0.139***	0.135***	0.164***	0.150***	0.0983***	9.098***	0.0501**	0.139***	0.107***	0.0989***
	(1.384)	(0.020)	(0.047)	(0.048)	(0.045)	(0.040)	(0.038)	(1.368)	(0.020)	(0.047)	(0.031)	(0.026)
Ref: High school or below												
Mother: Higher than University	-0.870	-0.0233	0.707***	-0.0658	0.301**	0.237*	0.406***	-0.725	-0.0355	0.687***	0.0754	0.227**
	(4.306)	(0.071)	(0.218)	(0.144)	(0.143)	(0.135)	(0.154)	(4.234)	(0.071)	(0.217)	(0.094)	(0.102)
Mother: Junior college	12.60***	0.0809	-0.256	0.131	0.0338	-0.0683	-0.0843	12.39***	0.0838	-0.251	0.0692	-0.0363
	(4.710)	(0.081)	(0.216)	(0.150)	(0.150)	(0.167)	(0.164)	(4.664)	(0.081)	(0.216)	(0.100)	(0.117)
Mother: Unknown	-9.590**	-0.0337	0.268	-0.309*	-0.0293	0.414**	0.338**	-9.449**	-0.0397	0.260	-0.140	0.283***
	(4.552)	(0.077)	(0.165)	(0.160)	(0.146)	(0.168)	(0.155)	(4.532)	(0.077)	(0.167)	(0.099)	(0.107)
Father: Higher than University	-0.305	0.140**	1.143***	0.239*	0.205	-0.00972	0.0401	-0.200	0.142**	1.145***	0.178**	0.0351
	(4.359)	(0.066)	(0.186)	(0.133)	(0.136)	(0.137)	(0.126)	(4.350)	(0.066)	(0.185)	(0.091)	(0.090)
Father: Junior college	-6.517	-0.0155	-0.768***	-0.245	-0.0658	-0.0515	0.105	-5.627	-0.0224	-0.775***	-0.142	0.00708
	(6.249)	(0.081)	(0.224)	(0.190)	(0.238)	(0.209)	(0.200)	(6.227)	(0.082)	(0.222)	(0.142)	(0.136)
Father: Unknown	-0.977	0.107	0.339*	-0.0699	-0.165	-0.447***	-0.178	-0.996	0.108	0.336*	-0.0788	-0.220**
	(4.473)	(0.070)	(0.177)	(0.154)	(0.154)	(0.161)	(0.136)	(4.439)	(0.070)	(0.179)	(0.102)	(0.098)
Children born between January 1and April 1	-11.22***	0.0585	-0.107					-10.71***	0.0529	-0.114		
	(3.587)	(0.048)	(0.119)					(3.612)	(0.048)	(0.117)		
Experiences of being bullied		0.000439							-0.000626			
		(0.026)							(0.026)			
Total enrolment of students (in hundreds)	-0.526	-0.0152	-0.0211					-0.796	-0.0150	-0.0202		
	(1.195)	(0.021)	(0.029)					(1.209)	(0.021)	(0.029)		
Location of school	3.779	-0.0357	0.165*					4.962*	-0.0325	0.170**		
	(2.510)	(0.043)	(0.086)					(2.546)	(0.043)	(0.085)		
Private or national school	16.82*	0.206*	0.834***					10.74	0.213*	0.846***		
	(10.030)	(0.118)	(0.231)					(11.120)	(0.117)	(0.228)		
School-P	9.278**	-0.0980	0.153					11.98***	-0.102	0.148		
	(4.333)	(0.063)	(0.106)					(4.535)	(0.063)	(0.105)		
Income level of school area	0.158	0.0265	0.140					-2.694	0.0287	0.144		
	(4.153)	(0.078)	(0.141)					(4.254)	(0.077)	(0.140)		
% of economically disadvantaged students	-0.819	0.00561	-0.0157					-1.238	0.00677	-0.0130		
	(3.756)	(0.054)	(0.103)					(3.661)	(0.055)	(0.102)		
Class size	-0.473	-0.00740	-0.0166					-0.344	-0.00794	-0.0170		
	(0.619)	(0.008)	(0.013)					(0.668)	(0.008)	(0.013)		
Random intercept of school	1							1				
	(0)							(0)				
Constant	402.2***	0.0577						383.5***	0.510		-1.269***	-0.853***
	(38.050)	(0.603)						(39.590)	(0.587)		(0.163)	(0.196)
Random intercept of school	1,789	1,789	1,789	1,789	1,789	1,789	1,789	1,789	1,789	1,789	1,789	1,789

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: AIC for Model 13a = 232999 and for Model 14a = 198764.

Table A. 10 Results for Eighth Grade with All the Control Variables (Female: Science)

	Female											
	Model 15a							Model 16a				
VARIABLES	Achievement	Attitude	Aspiration	Ask	Time	Check	Talk	Achievement	Attitude	Aspiration	Communicating	Monitoring
Ask	-2.859	-0.0564*	0.0212									
	(1.869)	(0.031)	(0.070)									
Talk	0.185	0.175***	0.133*									
	(2.042)	(0.034)	(0.073)									
Time	2.791	0.0201	0.0813									
	(1.902)	(0.029)	(0.064)									
Check	-2.445*	0.0624**	-0.0964									
	(1.478)	(0.027)	(0.065)									
Communicating								-1.772	0.0766***	0.110**		
								(1.174)	(0.021)	(0.044)		
Monitoring								0.178	0.0647***	-0.0182		
								(1.206)	(0.018)	(0.047)		
Science attitude	20.41***							20.36***				
	(1.482)							(1.477)				
Aspiration	28.57***							28.78***				
	(2.153)							(2.137)				
Possessions at home	4.020***	0.0223	0.238***	0.157***	0.170***	0.157***	0.0652*	4.111***	0.0214	0.241***	0.113***	0.0820***
	(1.182)	(0.019)	(0.033)	(0.040)	(0.044)	(0.041)	(0.038)	(1.196)	(0.019)	(0.033)	(0.025)	(0.027)
Possessions at home11	3.846	-0.0381	-0.501	-0.160	-0.209	-0.0202	0.163	3.160	-0.0344	-0.504		
	(7.881)	(0.136)	(0.399)	(0.288)	(0.240)	(0.309)	(0.304)	(7.931)	(0.137)	(0.397)		
Number of books at home	9.679***	0.121***	0.155***	0.143***	0.102**	0.0534	0.0977**	9.365***	0.123***	0.151***	0.0857***	0.0613**
	(1.352)	(0.022)	(0.050)	(0.038)	(0.042)	(0.043)	(0.043)	(1.340)	(0.022)	(0.050)	(0.025)	(0.029)
Ref: High school or below												
Mother: Higher than University	3.200	0.0985	1.322***	0.177	0.153	0.0957	0.0742	3.745	0.106	1.320***	0.114	0.0679
	(4.714)	(0.077)	(0.227)	(0.154)	(0.141)	(0.143)	(0.167)	(4.715)	(0.077)	(0.227)	(0.099)	(0.108)
Mother: Junior college	5.796	-0.0120	-1.030***	-0.217	-0.126	-0.173	-0.153	5.403	-0.0218	-1.028***	-0.108	-0.119
	(4.195)	(0.069)	(0.219)	(0.149)	(0.158)	(0.134)	(0.172)	(4.219)	(0.069)	(0.217)	(0.101)	(0.106)
Mother: Unknown	3.173	0.136	0.549***	-0.449**	-0.352**	-0.0536	0.0823	2.989	0.133	0.540***	-0.292**	0.00291
	(4.430)	(0.086)	(0.192)	(0.180)	(0.179)	(0.159)	(0.154)	(4.415)	(0.086)	(0.191)	(0.119)	(0.111)
Father: Higher than University	4.197	-0.000805	1.112***	-0.00687	0.112	0.109	0.0539	4.216	-0.00610	1.115***	0.0446	0.0613
	(3.969)	(0.062)	(0.157)	(0.115)	(0.123)	(0.135)	(0.135)	(3.979)	(0.061)	(0.157)	(0.077)	(0.097)
Father: Junior college	1.907	0.0359	-0.705***	0.281	0.156	0.118	0.147	2.317	0.0422	-0.704***	0.147	0.0903
	(5.882)	(0.102)	(0.207)	(0.176)	(0.188)	(0.176)	(0.178)	(5.909)	(0.101)	(0.208)	(0.121)	(0.130)
Father: Unknown	-1.415	-0.0482	0.262	-0.151	0.0755	-0.0537	-0.0720	-1.594	-0.0607	0.259	-0.0273	-0.0402
	(4.706)	(0.081)	(0.176)	(0.139)	(0.141)	(0.130)	(0.136)	(4.692)	(0.081)	(0.174)	(0.088)	(0.094)
Children born between January 1and April 1	-2.596	-0.0836	-0.268**					-2.580	-0.0792	-0.267**		
	(3.210)	(0.051)	(0.119)					(3.233)	(0.051)	(0.119)		
Experiences of being bullied		-0.000103							-0.00185			
		(0.027)							(0.028)			
Total enrolment of students (in hundreds)	0.0946	9.51e-05	0.0133					0.717	0.00168	0.0151		
	(1.116)	(0.017)	(0.034)					(1.159)	(0.018)	(0.034)		
Location of school	0.235	-0.0909**	-0.0391					-0.381	-0.0882*	-0.0416		
	(2.236)	(0.044)	(0.076)					(2.250)	(0.045)	(0.076)		
Private or national school	9.304	-0.0768	1.620***					5.406	-0.0858	1.621***		
	(8.318)	(0.172)	(0.274)					(8.804)	(0.176)	(0.277)		
School-P	1.310	-0.0541	0.170					1.319	-0.0564	0.169		
	(2.923)	(0.069)	(0.118)					(3.124)	(0.071)	(0.118)		
Income level of school area	8.577**	0.0900	0.338**					8.506**	0.0811	0.331**		
	(4.205)	(0.080)	(0.148)					(4.231)	(0.081)	(0.150)		
% of economically disadvantaged students	0.712	0.0584	0.0911					0.784	0.0559	0.0912		
	(3.420)	(0.063)	(0.100)					(3.537)	(0.063)	(0.100)		
Class size	-0.249	0.00475	-0.0185					-0.246	0.00378	-0.0188		
	(0.609)	(0.012)	(0.018)					(0.633)	(0.012)	(0.018)		
Random intercept of school	1							1				
	(0)							(0)				
Constant	407.5***	-0.832						398.8***	-0.282		-0.931***	-0.817***
	(28.420)	(0.622)						(30.380)	(0.629)		(0.187)	(0.185)
	1,812	1,812	1,812	1,812	1,812	1,812	1,812	1,812	1,812	1,812	1,812	1,812

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: AIC for Model 15a = 236617 and for Model 16a = 202366.

Bibliography

Akaike, H. (1987). Factor analysis and AIC. *Psychometrika*, *52*(3), 317-332.

Berzin, S. C. (2010). Educational Aspirations among Low-income Youths: Examining Multiple Conceptual Models. *Children & Schools*, *32*(2), 112-124.

Blazer, C. (2009). The Effect of Poverty on Student Achievement. Information Capsule. Volume 0901. *Research Services, Miami-Dade County Public Schools*.

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.

Domina, T. (2005). Leveling the home advantage: Assessing the effectiveness of parental involvement in elementary school. *Sociology of Education*, *78*(3), 233-249.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives* (pp. 75–146). San Francisco, CA: Freeman.

Epstein, J. L. (2001). *School, family, and community partnerships: Preparing educators and improving schools*. Westview Press.

Fan, X. (2001). Parental involvement and students' academic achievement: A growth modeling analysis. *The Journal of Experimental Education*, *70*(1), 27-61.

Fantuzzo, J., McWayne, C., Perry, M. A., & Childs, S. (2004). Multiple dimensions of family involvement and their relations to behavioral and learning competencies for urban, low-income children. *School Psychology Review*,*33*(4), 467.

Foy, P., Brossman, B., & Galia, J. (2011). Scaling the TIMSS and PIRLS 2011 achievement data. *TIMSS and PIRLS Methods and Procedures. Zugriff am*, *29*, 2013.

Frenzel, A. C., Goetz, T., Pekrun, R., & Watt, H. M. (2010). Development of mathematics interest in adolescence: Influences of gender, family, and school context. *Journal of Research*

on Adolescence, *20*(2), 507-537.

Frostick, C., Phillips, G., Renton, A., & Moore, D. (2016). The Educational and Employment Aspirations of Adolescents from Areas of High Deprivation in London. *Journal of youth and adolescence*, *45*(6), 1126-1140.

Frydenberg, E., & Lewis, R. (1991). Adolescent coping: The different ways in which boys and girls cope. *Journal of Adolescence*, *14*(2), 119-133.

Galindo, C., & Sheldon, S. B. (2012). School and home connections and children's kindergarten achievement gains: The mediating role of family involvement. *Early Childhood Research Quarterly*, *27*(1), 90-103.

García, T., Rodríguez, C., Betts, L., Areces, D., & González-Castro, P. (2016). How affective-motivational variables and approaches to learning predict mathematics achievement in upper elementary levels. *Learning and Individual Differences*, *49*, 25-31.

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.

Gonzalez, A. R., Holbein, M. F. D., & Quilter, S. (2002). High school students' goal orientations and their relationship to perceived parenting styles. *Contemporary Educational Psychology*, *27*(3), 450-470.

Gottfried, A. E., Fleming, J. S., & Gottfried, A. W. (1994). Role of parental motivational practices in children's academic intrinsic motivation and achievement. *Journal of Educational Psychology*, *86*(1), 104.

Grolnick, W. S., Ryan, R. M., & Deci, E. L. (1991). Inner resources for school achievement: Motivational mediators of children's perceptions of their parents. *Journal of educational psychology*, *83*(4), 508.

Grolnick, W. S., & Slowiaczek, M. L. (1994). Parents' involvement in children's schooling: A multidimensional conceptualization and motivational model. *Child Development*, *65*(1), 237-252.

Heck, R. H., & Thomas, S. L. (2015). *An introduction to multilevel modeling techniques: MLM and SEM approaches using Mplus*. Routledge.

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), 1491-1509.

Hill, N. E., & Taylor, L. C. (2004).Parental school involvement and children's academic achievement pragmatics and issues. *Current directions in psychological science*, *13*(4), 161-164.

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.

Hill, N. E., & Wang, M. T. (2015). From middle school to college: Developing aspirations, promoting engagement, and indirect pathways from parenting to post high school enrollment. *Developmental Psychology*, *51*(2), 224.

Hoover-Dempsey, K. V., & Sandler, H. M. (1995). Parental involvement in children's education: Why does it make a difference?. *Teachers College Record*, *97*, 310-331.

Hoover-Dempsey, K. V., Walker, J. M., Sandler, H. M., Whetsel, D., Green, C. L., Wilkins, A. S., &Closson, K. (2005). Why do parents become involved? Research findings and implications. *The Elementary School Journal*, *106*(2), 105-130.

Jung, E., & Zhang, Y. (2016). Parental involvement, children's aspirations, and achievement in new immigrant families. *The Journal of Educational Research*,*109*(4), 333-350.

Kawaguchi, D. (2011). Actual age at school entry, educational outcomes, and earnings. *Journal of the Japanese and International Economies*, *25*(2), 64-80.

Lee, J. S., & Bowen, N. K. (2006). Parent involvement, cultural capital, and the achievement gap among elementary school children. *American Educational Research Journal*, *43*(2),

193-218.

Lee, J., & Fish, R. M. (2010). International and interstate gaps in value-added math achievement: Multilevel instrumental variable analysis of age effect and grade effect. *American Journal of Education*, *117*(1), 109-137.

Leung, C. H., Chen, S. X., & Lam, B. C. (2010). Where there's a will, there's a way: The mediating effect of academic aspiration between beliefs and academic outcomes. *Journal of Psychology in Chinese Societies*, *11*(1), 53.

Lipnevich, A. A., Preckel, F., & Krumm, S. (2016). Mathematics attitudes and their unique contribution to achievement: Going over and above cognitive ability and personality. *Learning and Individual Differences*, *47*, 70-79.

Lloyd, J., & Barenblatt, L. (1984). Intrinsic intellectuality: Its relations to social class, intelligence, and achievement. *Journal of Personality and Social Psychology*, *46*(3), 646.

McNeal, R. B. (1999). Parental involvement as social capital: Differential effectiveness on science achievement, truancy, and dropping out. *Social Forces*,*78*(1), 117-144.

McNeal, R. B. (2014). Parent Involvement, Academic Achievement and the Role of Student Attitudes and Behaviors as Mediators. *Universal Journal of Educational Research*, *2*(8), 564-576.

McNeal Jr, R. B. (2015). Parent involvement and student performance: the influence of school context. *Educational Research for Policy and Practice*,*14*(2), 153-167.

Milne, A. M., Myers, D. E., Rosenthal, A. S., & Ginsburg, A. (1986). Single parents, working mothers, and the educational achievement of school children. *Sociology of Education*, 125-139.

Moon, U. J., & Hofferth, S. L. (2016). Parental involvement, child effort, and the development of immigrant boys' and girls' reading and mathematics skills: A latent difference score growth model. *Learning and individual differences*, *47*, 136-144.

Muller, C. (1998). Gender differences in parental involvement and adolescents' mathematics

achievement. *Sociology of Education*, 336-356.

Núñez, J. C., Suárez, N., Rosário, P., Vallejo, G., Valle, A., & Epstein, J. L. (2015). Relationships between perceived parental involvement in homework, student homework behaviors, and academic achievement: differences among elementary, junior high, and high school students. *Metacognition and Learning*,*10*(3), 375-406.

Patall, E. A., Cooper, H., & Robinson, J. C. (2008). Parent involvement in homework: A research synthesis. *Review of educational research*, *78*(4), 1039-1101.

Perry, D. G., & Pauletti, R. E. (2011). Gender and adolescent development.*Journal of Research on Adolescence*, *21*(1), 61-74.

Plunkett, S. W., Behnke, A. O., Sands, T., & Choi, B. Y. (2009). Adolescents' reports of parental engagement and academic achievement in immigrant families. *Journal of youth and adolescence*, *38*(2), 257-268.

Pong, S. L. (1997). Family structure, school context, and eighth-grade math and reading achievement. *Journal of Marriage and the Family*, 734-746.

Schumacker, R. E., & Lomax, R. G. (2010). *A beginner's guide to structural equation modeling* (3rd ed.). Psychology Press.

Shumow, L., Lyutykh, E., & Schmidt, J. A. (2011). Predictors and outcomes of parental involvement with high school students in science. *School Community Journal*, *21*(2), 81.

Shumow, L., & Miller, J. D. (2001). Parents' at-home and at-school academic involvement with young adolescents. *The Journal of Early Adolescence*, *21*(1), 68-91.

Simpkins, S. D., Price, C. D., & Garcia, K. (2015). Parental support and high school students' motivation in biology, chemistry, and physics: Understanding differences among Latino and caucasian boys and girls. *Journal of Research in Science Teaching*, *52*(10), 1386-1407.

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.

Spera, C. (2006). Adolescents' perceptions of parental goals, practices, and styles in relation to their motivation and achievement. *The Journal of Early Adolescence*, 26(4), 456-490.

Steinmayr, R., & Spinath, B. (2009). The importance of motivation as a predictor of school achievement. *Learning and Individual Differences*, *19*(1), 80-90.

Sui-Chu, E. H., & Willms, J. D. (1996). Effects of parental involvement on eighth-grade achievement. *Sociology of Education*, 126-141.

Skues, J. L., Cunningham, E. G., & Pokharel, T. (2005). The influence of bullying behaviours on sense of school connectedness, motivation and self-esteem. *Journal of Psychologists and Counsellors in Schools*, *15*(1), 17-26.

Villavicencio, F. T., & Bernardo, A. B. (2013). Positive academic emotions moderate the relationship between self-regulation and academic achievement. *British Journal of Educational Psychology*, *83*(2), 329-340.

Wang, M. T., & Sheikh-Khalil, S. (2014). Does parental involvement matter for student achievement and mental health in high school?. *Child Development*,*85*(2), 610-625.

Warton, P. M. (1997). Learning about responsibility: Lessons from homework. *British Journal of Educational Psychology*, *67*(2), 213-221.

Wiklund, M., Malmgren-Olsson, E. B., Öhman, A., Bergström, E., & Fjellman-Wiklund, A. (2012). Subjective health complaints in older adolescents are related to perceived stress, anxiety and gender–a cross-sectional school study in Northern Sweden.*BMC public health*, *12*(1), 1.

Xu, J. (2005). Purposes for doing homework reported by middle and high school students. *The Journal of Educational Research*, *99*(1), 46-55.

Young-Jones, A., Fursa, S., Byrket, J. S., & Sly, J. S. (2015). Bullying affects more than feelings: the long-term implications of victimization on academic motivation in higher education. *Social psychology of education*, *18*(1), 185-200.

Zhan, M. (2006). Assets, parental expectations and involvement, and children's educational

performance. *Children and Youth Services Review, 28*(8), 961-975.