JOINT RESEARCH CENTER FOR PANEL STUDIES
SELECTED DISCUSSION PAPER SERIES

SDP2012-007
March, 2013

The structure of the effects of family background on children's academic ability —An investigation using hierarchical multiple regression analysis and structural equation modeling

Keita Shinogaya*
Hideo Akabayashi**

【Abstract】
In this paper, we used data from the Japan Child Panel Survey (JCPS) 2010-2011 to investigate the process by which family background, such as parents' educational attainment and household income, affects children's academic ability. In particular, we focused on "investment in education" and "the amount of time children spend learning" as the mediate variables, and for the analysis, we used both a hierarchical multiple regression analysis and structural equation modeling. Since the relationship between family background and academic ability may change as the child grows, the differences between elementary and junior high students in terms of this relationship were also investigated. As a result, it was ascertained that parents' educational attainment and household income not only mediate the establishment of a cultural environment within the home, investment in after-school (extracurricular) activities, and the time the children spend learning but also, through these variables, affect children's academic abilities. Moreover, the analyses suggested that there may be differences between elementary and junior high students for the following relationships: (1) between the father's educational attainment and children's time spent studying; (2) between household income and children's academic ability; (3) between investment outside the home and children's time spent studying; and (4) between household income and investment inside the home.

* Keio Advanced Research Centers
** Faculty of Economics, Keio University)

Joint Research Center for Panel Studies
Keio University

The structure of the effects of family background on children's academic ability
—An investigation using hierarchical multiple regression analysis and structural equation modeling—[1]

Keita Shinogaya (Keio Advanced Research Centers) and
Hideo Akabayashi (Faculty of Economics, Keio University)

Summary

In this paper, we used data from the Japan Child Panel Survey (JCPS) 2010-2011 to investigate the process by which family background, such as parents' educational attainment and household income, affects children's academic ability. In particular, we focused on "investment in education" and "the amount of time children spend learning" as the mediate variables, and for the analysis, we used both a hierarchical multiple regression analysis and structural equation modeling. Since the relationship between family background and academic ability may change as the child grows, the differences between elementary and junior high students in terms of this relationship were also investigated. As a result, it was ascertained that parents' educational attainment and household income not only mediate the establishment of a cultural environment within the home, investment in after-school (extracurricular) activities, and the time the children spend learning but also, through these variables, affect children's academic abilities. Moreover, the analyses suggested that there may be differences between elementary and junior high students for the following relationships: (1) between the father's educational attainment and children's time spent studying; (2) between household income and children's academic ability; (3) between investment outside the home and children's time spent studying; and (4) between household income and investment inside the home.

---

[1] Corresponding author: K. Shinogaya (email: kshinogaya@yahoo.co.jp).
Originally Published as Chapter 4 in Y. Higuchi, T. Miyauchi, C. R. McKenzie and Keio University Joint Research Center for Panel Studies (eds.), *Oyako Kankei to Kakei Koudou no Dainamizumu (Dynamism of Parent-Child Relationship and Household Behavior)*. Keio University Press, pp. 81–101, in June 2012 in Japanese. This English version was translated into by an external translation service supplier in March 2013. Note that information included in this paper is as of March 2012.

Section 1 Problems and Objectives[2]

Since the Ministry of Education, Culture, Sports, Science and Technology (MEXT) implemented its *Manabi no Susume 2002* (Encouragement for Learning 2002) campaign, Japan has taken a very different path from the "Yotori Education (pressure-free education)" path it took during the 1990s. This so-called "Yutori Education" first appeared in the Government's Courses of Study in its Revision No. 4 in 1977 (Shimizu, 2005). Against the backdrop of the continuously high economic growth Japan's economic society achieved during its post-war recovery period in the 1960s and 1970s, for its school education, Japan established and maintained a curriculum that prioritized the systematization of knowledge.

During the same period of time, Japanese society began to pay more attention to school-related problems such as bullying and truancy. Some researchers argued that the causes of these problems arose from the stress felt by students being forced to learn so much knowledge and to take part in the fiercely competitive entrance exams; compounding this was the excessive importance society placed on a person's educational attainment (e.g., Ichikawa, 2002). It was in this sort of environment that the fifth revision to the Government's Courses of Study was released in 1989, which reflected Japan's "new outlook on academic ability"; then, in the 1990s, the government developed in earnest its policy of " Yotori Education."[3]

However, following the introduction of this new policy, researchers began debating more intensively on the issue of children's academic ability in Japan, more specifically the perceived decline in academic abilities and the increase in disparity between their achievements. For example, Kariya and Shimizu (2004) used the same group of schools and problems as were used in

[2]This research was supported by a Grant-in-Aid for Scientific Research (A) 20243020. Additionally, part of this paper was presented in a workshop during the Keio University Joint Research Center for Panel Studies, held by Keio University in December 2011. The authors would like to express their gratitude for help they received from the following team of joint researchers in carrying out this research and writing this paper: Chizuru Shikishima, Jun Yamashita, Ryosuke Nakamura, Michio Naoi, Hiroko Araki, Sachi Aizawa, and several others.

[3] Please refer to Iwaki (2004) for a description of the new academic outlook and Akabayashi (2010) for a summary of government educational policy before and after the bubble economy.

a study 20 years previously; they compared children's basic knowledge and skills for arithmetic, mathematics, and Japanese.

They found (a) that the children's percentage of correct answers had declined for the educational content that had been reduced or for which explanations had been abbreviated by the “Yutori Education” policy, and (b) that this policy had brought about a decline in children’s academic ability in terms of their basic knowledge. Moreover, this research did not merely entail comparing test scores from the past and the present; rather, it also investigated the predominant age groups wherein children lagged behind their peers in cognitive development—namely, those who could not keep up in their learning—and the age groups in which the academic ability gap between children was widening. The researchers found that there has been an increase in children lagging behind in academic ability compared to 20 years ago and, of note, that this tended to occur in the upper-elementary grades. Their research also showed that the number of rapid learners—those students who had learned the content of the academic year above their year—had increased in the upper-elementary grades. In this way, Kariya and Shimizu (2004) empirically demonstrated that during the period when the “Yutori Education” policy was developed, not only had there been a decline in children's academic ability in terms of their basic knowledge, but there had also been a widening of the disparity in their academic abilities.

Hence, the question remained as to what caused this decline in and a widening of the disparity of their academic ability. Researchers usually point to economic and social factors in the home as the variables that determine academic ability. For example, Kariya and Shimizu (2004) and Akabayashi et al. (2011) found that children's academic ability is determined by their parents' educational attainment and income, which suggests that the increase in the disparities between social strata and the worsening situation of the poorest segment of the population that has taken place in recent years may be responsible for the decline in children’s academic abilities (Kariya, 2001).

However, it is difficult to say that there has been sufficient empirical research conducted regarding the process by which family background factors, such as parents’ educational attainment and income, affect children's academic ability. On this point, the Japanese Household Panel Research (subsequently, JHPS) and the Keio Household Panel Research (subsequently,

KHPS) carried out a questionnaire survey that measured variables including household income and parents' educational attainment, but also implemented it in parallel with the Japan Child Panel Survey, called JCPS, which included a survey on children's learning behavior and a test of children's academic abilities. This created a survey design capable of analyzing variables on both the various household-related factors and on children's learning. The analyses in this research used the sample data from JCPS2010 and JCPS2011 and, while assuming various mediate variables, investigated the process by which households' economic and social factors, such as parents' educational attainment and income, affect children's academic abilities.

For the analytical framework in this research, in addition to the correlation that family background factors, (i.e., parents' educational attainment and income) have with genetic factors, the effects that parents have on their children's academic ability through their investments in education were also considered. Thus, there are two behavioral processes for parents to invest in their children's education: investment in education inside the home and outside the home.

Investment inside the home is defined as establishing and maintaining a cultural environment within the children's daily home lives; it includes having books in the home, enabling children to access information via the Internet, having arts in the home, having musical instruments, and preparing a study room or study desk. Kariya (2001) pointed to the importance of this sort of cultural environment within the home as a factor affecting children's academic ability, while Akabayashi et al. (2011) discovered a correlation between children's academic abilities in mathematics and Japanese, and the variables of (a) whether or not they had Internet access or musical instruments at home and (b) the number of books within the home. In this research, the authors investigated investment in education inside the home based on this previous research.

On the other hand, investment outside the home is defined as investment in learning intended to improve the child's academic abilities; in addition to general school expenses, it includes investment in cram schools, home tutors, use of the Japanese abacus, calligraphy, and so on. It is highly likely that parents with a high educational attainment place a high value on the level of their children's education and, furthermore, anticipate a high rate of return

from such investments in their children's education (Becker, 1991). Moreover, even among parents who attach the same value to investment in education, in an imperfect market the higher a household's income, the fewer the credit constraints that are placed upon it; theoretically, these households can be expected to achieve the optimum level of investment. In this research, these variables were considered to be mediate variables, and the effects they have on children's academic ability were investigated.

In addition to the above, the analyses in this research not only investigated the behavior of parents in terms of their investment in education, but also included analyses of children's behavior as a mediate variable, as the amount that the child studies each day is thought to affect his or her academic abilities.

Kariya (2008) compared students whose parents had a high education background (specifically, having graduated from a college or a junior college) to those whose parents did not, and found that children whose parents graduated from high school spent significantly less time studying at home. If we consider this result in conjunction with the aforementioned disparities in academic abilities between social strata, it is likely that the problems of the decline in academic ability and increase in disparities in academic ability that have arisen in recent years are to some extent the result of the home-environment factor influenced by parents' educational attainment, as it is likely to affect the amount of studying the child does at home. Undoubtedly, the amount of studying that children do during their daily lives is an important factor in determining their academic abilities. In order to address the problems of children's declining academic abilities and the growing disparity between their academic abilities, it is necessary to investigate the process by which parents' educational attainment and income affects their children's academic abilities by considering how they mediate the amount of time children spend studying. For example, in many cases when the parents' educational levels are high, household income is also high, and so these households frequently invest in education both inside and outside the home. Beyond this, it is likely that this investment and children's study are complementary within education production, which makes it possible for children to learn even more. In this way, it is likely that the process by which family background affects children's academic ability is

also a crucial variable, as it mediates the amount that children study each day.

However, family background is not the only factor that determines the amount that children study. For example, the amount of homework that a school gives its students can be a factor affecting the amount of studying that they do at home. In recent years, even the Japanese Government has come to re-recognize the importance of children getting into the habit of studying at home. MEXT (2008) encouraged schools to actively give homework to their students in order to increase the amount that they study (e.g., Mimizuka, 2007). Based on this, in this research the frequency with which schools give their students homework was used as a control variable in the analyses.

It is thought that the effects of family background on children's academic abilities are not constant across the years they attend school. In particular, with the growth of children through the lower-elementary grades, upper elementary, and junior high, there are certainly significant changes in the percentage of time that children spend with their parents during their daily activities. As a result, it is reasonable to anticipate there will also be differences in the process by which parents influence children.

However, research in Japan so far has not provided any clear indications on whether the influence that the family background factors—such as parents' educational attainment and income—and investment in education have on children's academic ability varies according to the child's growth stage. Therefore, this research sought to determine whether there are changes (and if so to what extent) in the process by which family background affects children's academic ability during the period from when they are in the second half of elementary to when they are in junior high—as researchers have argued that it is during this time period when the disparities between students start to increase.

Specifically, in order to explore and investigate the differences in the process by which family background affects children's academic ability, we used both hierarchical multiple regression analysis and structural equation modeling (SEM), which are standard tools in psychology and sociology, to compare children in the upper-elementary grades (fourth, fifth, and sixth grades of elementary school) to junior high students (first, second, and third

grade of junior high).

The cause-and-effect step analysis is an analytical method involving a repeated multiple regression analysis to investigate the relationship between variables; this has been used in various prior investigations into psychological processes (e.g., Barron & Kenny, 1986; MacKinnon, Fairchild, Fritz, 2007; Spencer, Zannna, & Fong, 2005; Shinogaya, 2008). SEM is an analytical method that attempts to clarify the relationship among variables from the perspective of goodness of fit between an estimated model and data. To investigate the relationships between multiple variables, as described above, SEM involves repeated multiple regressions analyses to find coefficients at the same time as analyzing all causal relationships. It can be said that this method of calculating coefficients, through repeated multiple regression analyses, is a convenient and useful tool in order to determine which variables are related; moreover, another advantage of SEM is that the relationship between all the variables can be closely examined from the perspective of goodness of fit with the data..[4]

In Section 2 below, the data and variables used in the analyses are explained. In Section 3, the results of the analyses based on the cause-and-effect steps of hierarchical multiple regression analyses are shown. In Section 4, the results of the SEM analyses are shown. In Section 5, the results of the analyses are compared and interpreted, while in Section 6, issues for the future are discussed.

Section 2 The Data and Variables Used in the Analyses

(1) Research subjects

The research subjects for this investigation were the households of parents and children who participated in the Japan Child Panel Survey 2010-2011

[4] As an introductory explanation of SEM, see Kline (2010) for example. Specifying the causal relationships through SEM is based on theoretical and empirical considerations hypothesized in advance, not within SEM. However, on the point that a causal model created in conjunction with experimental controls cannot provide suggestions for an overall image of the factors influencing academic ability, SEM is considered to be one of the more useful methods of exploratory research (Kline p. 98–101). In recent years, the literature on structural estimates of human capital production functions has actively used the estimation methods developed in SEM (Cunha & Heckman, 2007).

(subsequently, JCPS2010-11) from samples within the 2010 Japan Household Panel Survey 2010 (JHPS2010), and the 2011 Keio Household Panel Survey 2011 (KHPS2011)[5]. The survey consisted of a questionnaire answered by the parents and academic ability test and a questionnaire answered by the children. The objective of this research was to investigate the relationship between family background and children's academic ability, while also considering the investments made by parents and the children's learning behavior. However, as the questionnaires answered by children below the age of the third grade of elementary school do not include questions on the time they spent studying outside of school or the frequency for which they were given homework, the subjects for analysis in this research were limited to children from the fourth grade of elementary to the third grade of junior high (attending public schools) and the parents of these children. We used the data set of 392 children and their parents, all of which was complete and without defects (68 elementary fourth graders, 71 elementary fifth graders, 64 elementary sixth graders, 68 junior high first graders, 72 junior high second graders, and 49 junior high third graders).

(2) Measurements

Family background

(i) The parents' educational attainment

For the question to identify the highest educational level achieved by the fathers and mothers of the children who took part in the JCPS2010-11 survey, participants were required to select one of five choices: graduated from 1 (Junior high school), 2 (High school), 3 (Some college), 4 (Graduate school), or 5 (Other). For the analysis of the data obtained from this question on the fathers' and mothers' educational attainment, a dummy variable of whether or not the respondent had graduated from some college was used, with respondents graduating from some college or graduate school being assigned a value of 1 and all other respondents being assigned a value of 0.

(ii) Household income

The answers provided by respondents in all households to the question

[5]Please refer to Akabayashi et al. (2011) and Akabayashi et al. (2012) for an overview of the survey in the last two years.

quantifying their income to the nearest 10,000 yen in the year before the survey year were used for the analyses in this research.

(iii) Investment inside the home

In this research, in order to measure investment inside the home, the answers provided by the respondents to the questions within the JCPS on the cultural and educational environment within the home were used for the analyses. Values were allocated to six questions regarding whether the home had Internet access, arts, musical instruments, a room or desk for study, as well as the number of books they had. The respondent was given 1 for each of these items described above that it had (0 if it did not have it), while for the number of books in the home, the following scores were given: 0 (no books), 1 (less than ten books), 2 (from 10 to less than 50 books), 3 (from 50 to less than 100 books), 4 (from 100 to less than 300), and 5 (300 or more books). After all the scores from the six items on investment within the home were standardized, a principal component analysis was carried out and the composite scores employing weighted coefficients from the first principal component were used for the analyses.[6]

(iv) Investment outside the home

In the JPCS, in order to analyze the extent of parents' investment in their children's learning outside the home, they were asked how much they paid monthly for fees for after-school activities, and their responses were used for the analyses.

Variables relating to the children

(i) Time spent studying

In the JPCS, the children were questioned on the amount of time they spent studying each day after returning home from school, with the choices being as follows: 1 (hardly at all), 2 (for about 30 minutes), 3 (for about one hour), 4 (for about two hours), 5 (for about three hours), 6 (for about four

[6] This method does not simply total the test item scores, but adds weights to the scores based on the principal component analysis; as a result, scores that clearly show individual differences can be calculated (Adachi, 2006).

hours), and 7 (five hours or more). These scores were used in the analysis of this variable as indicators of the amount of study done outside of school. The answers for this question included the time spent studying at cram schools and with home tutors.

(ii) Academic ability

The JCPS academic ability test includes problems for students in each academic year on mathematics, Japanese, and reasoning. In this research, an analysis was not conducted for scores from the reasoning problems, because Akabayashi et al. (2011) had found they were not significantly correlated with any variable. Thus, only the test scores for mathematics and Japanese were used as indicators of the children's academic abilities. The math problems were basic calculations and story-based problems, while the Japanese problems tested the children's knowledge of *kanji* (Chinese characters used in Japanese) and their vocabulary. For each problem, a score of 1 was given for a correct answer, the simple totaled scores were standardized for each academic year and each question, and then these scores were used in the analyses in this research.

Section 3 Results of the Hierarchical Multiple Regression Analysis

Following on from previous research, a hierarchical multiple regression analysis was conducted to investigate the relational processes between the variables acquired from the methods described.[7] In order to clarify the process by which family background factors affect children's academic abilities through a comparison of elementary and junior high students, the data was divided into data sets of elementary and junior high students.

(1) The relationship between parents' educational attainment and household income

A multiple regression analysis was carried out with the dummy variable of the father's and the mother's educational attainment input as an independent variable and household income set as the subordinate variable. Table 1 shows

[7] Please refer to the Appendix for the simple tabulations for each variable and the descriptive statistics.

the results of the analyses for both elementary and junior high students. The values within the table are standardized partial regression coefficients. For elementary students, both the father's educational attainment dummy variable and the mother's educational attainment dummy variable were found to be significantly correlated to household income. On the other hand, for junior high students, only the father's educational attainment was significantly correlated to household income.

Table 1 The relationship between parents' educational attainment and household income

	Elementary students (N = 203)	Junior high students (N = 189)
Father's educational attainment	.309***	.205***
Mother's educational attainment	.161***	.085
ΔR^2	.153***	.059***

Note: The numerical values are standardized partial regression coefficients.

*p < .10, **p < .05, and ***p < .01

(2) The relationship between parents' educational attainment and household income and investment in education

Next, the relationships between the parents' educational attainment and household income and their investment both inside and outside the home were investigated. The dummy variables of the father's and the mother's educational attainment were input as the Step 1 independent variable and household income as the Step 2 independent variable; the scores for investment inside the home and investment outside the home were defined as the subordinate variables; and a hierarchical multiple regression analysis

was carried out. Table 2 shows the results of the analyses for both elementary and junior high students. For elementary students, when the score for investment inside the home was set as the subordinate variable, in the analysis for both Step 1 and Step 2, a significant correlation was observed with the dummy variables of the father's and the mother's educational attainment. However, for junior high students, in Step 1, a significant correlation was seen with the father's educational attainment, but the correlation with the mother's educational attainment was only marginally significant; at the same time, in Step 2, the effects of the father's educational attainment and the effects of household income showed significance, albeit no effects were observed for the mother's educational attainment.

On the other hand, when investment outside the home was set as the subordinate variable for elementary students, in Step 1 the effects of the father's educational attainment dummy variable showed significance, but in Step 2, only household income showed a correlation with investment in education and no effects were observed from parents' educational attainment. These results suggest that parents' educational attainment mediates household income to affect investment outside the home. In addition, no significant effects were observed for any of the variables for junior high students.

Table 2 Results of the analysis when investment in education was the subordinate variable

	Elementary students (N = 203)				Junior high students (N = 189)			
	Investment inside the home		Investment outside the home		Investment inside the home		Investment outside the home	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Father's educational attainment	.240***	.243***	.161**	.119	.203***	.174**	.108	.088
Mother's educational	.245***	.246***	.088	.066	.131*	.119	-.077	-.085

attainment								
Household income		-.007		.135*		.143**		.098
ΔR^2	.156***	.000	.043**	.015	.074***	.019**	.013	.009

Note: The numerical values are standardized partial regression coefficients.

*$p < .10$, **$p < .05$, and ***$p < .01$

(3) The relationship between family background and the amount of time children spend studying

Next, with the amount of time children spent studying as the dependent variable, the independent variables were set as follows: in Step 1, the dummy variable of the father and the mother's educational attainment; in Step 2, household income; and in Step 3, the scores for investment inside and outside the home were set as the independent variable, and the hierarchical multiple regression analysis was carried out. Additionally, as the control variable, the frequency with which the school allocated homework was input into the Step 3 independent variable. Table 3 shows the results of this analysis.

For elementary students, investment inside and outside the home showed statistically significant correlations with the amount of time the children spent studying. As evidence in Step 2, the correlation between household income and the amount of time the children spent studying was significant, but no such significant effects were observed in Step 3. When considering this result in conjunction with the significant correlation observed in the previous analysis between household income and investment outside the home, it suggests that the effects that household income has on the amount of time the children spent studying may occur while mediating investment outside the home.

On the other hand, for junior high students, not only were effects observed in Step 3 from investment inside and outside the home and the frequency with which schools allocate homework, but significant effects were also consistently observed from Steps 1 to 3 for the dummy variable of the father's educational attainment. In other words, in the case of junior high

students, this result suggests that the variables of the father's educational attainment and the amount of time the children spent studying do not have merely an indirect relationship that mediates the variables pertaining to investment in education, but also a direct relationship that does not mediate these variables.

Table 3 Results of the analysis with the time spent studying as the subordinate variable

	Elementary students (N = 203)			Junior high students (N = 189)		
	(1),	(2),	(3),	(1),	(2),	(3),
Father's educational attainment	.133	.077	-.006	.214***	.218***	.164**
Mother's educational attainment	-.006	-.035	-.104	.071	.073	.073
Household income		.18**	.135		-.020	-.067
Investment inside the home			.162**			.146**
Investment outside the home			.368***			.163**
Homework frequency			.062			.127*
ΔR^2	.017	.028**	.176***	.059***	.000	.066***

Note: The numerical values are standardized partial regression coefficients.

*p < .10, **p < .05, and ***p < .01

(4) The relationship between family background and daily study and children's academic ability

Finally, Table 4 shows the results of the hierarchical multiple regression analysis with the academic ability score as the subordinate variable. For this analysis, time spent studying was added as a Step 4 independent variable. For elementary students, in Step 1 and Step 2 the father's educational attainment demonstrated a statistically significant correlation with the children's academic ability; however, from Step 3 onward, this coefficient diminished, and in Step 4, only investment inside the home was significantly correlated with the children's academic ability. This result suggests that the

effects of parents' educational attainment on children's academic ability may occur while mediating investment inside the home.

Table 4 Results of the analysis with children's academic ability as the subordinate variable

	Elementary students (N = 203)				Junior high students (N = 189)			
	(1),	(2),	(3),	(4),	(1),	(2),	(3),	(4),
Father's educational attainment	.223***	.212**	.131*	.132*	.190**	.147*	.089	.069
Mother's educational attainment	.016	.010	-.073	-.065	.083	.065	.062	.053
Household income		.036	.027	.017		.212***	.164**	.172**
Investment inside the home			.280***	.267**			.159**	.141*
Investment outside the home			.108	.080			.130*	.110
Homework frequency			.081	.076			.165**	.149**
Time spent studying				.077				.123*
ΔR^2	.052***	.001	.093***	.005	.052**	.042***	.070***	.013

Note: The numerical values are standardized partial regression coefficients. $^{*}p < .10$, $^{**}p < .05$, and $^{***}p < .01$

In addition, even for junior high students, in Step 1 and Step 2 the effects of the father's educational attainment were significant, but in the analysis from Step 3 onward, this significance was not observed. Conversely, the variables of household income and investment inside the home, time spent studying, and the frequency with which schools allocated homework showed a

systematic relationship with children's academic ability. When considering this in conjunction with the results obtained from the analyses so far, it suggests that the effects of parents' educational attainment occur while mediating household income, investment in education, and time spent studying.

Section 4 The SEM Analysis

The analyses up to this point have suggested the direct and indirect effects of parents' educational attainment and household income on children's academic ability. They also indicate that these relationships may differ depending on whether the child is a junior high student or an elementary student.

The relational processes between variables shown by these results were then analyzed using the maximum likelihood estimations with SEM. We employed a multiple population analysis. The stages of this analysis were as follows: (1) constructing the optimal model for the entire sample, (2) analyzing each group and confirming the model's goodness of fit, and (3) investigating the parts of the relationships between the variables that were different between the groups (Kawabata, 2007).

First, based on the results of the analyses up to this point, models were created for the relationships between the father and the mother's educational attainment, household income, the score for investment inside the home, the score for investment outside the home, homework frequency, the amount of time children spent studying, and the children's academic ability; the creation of an optimal model was investigated for the entire sample. Amos (ver. 5) was used for this analysis. The model was amended while using the modification indices as a clue, and the model that was finally used is shown in Figure 1. The values for the goodness of fit indexes for each of the models were GFI = .985, AGFI = .960, CFI = .959, and RMSEA = .045[8], showing that this model fit for the data. Further, when using the data sets from both

[8]In SEM, various indicators are used for goodness of fit between the model and the data. Generally, the model is considered to fit the data when GFI, AGFI, and CFI are 0.95 or over and RMSEA is less than 0.05 (Murohashi, 2003).

elementary and junior high students to calculate the models' goodness of fit, in the sample for the elementary students the values for the goodness of fit indexes were GFI = .971, AGFI = .918, CFI = .930, and RMSEA = .067, while for the junior high students they were GFI = .979, AGFI = .942, CFI = .963, and RMSEA = .037.

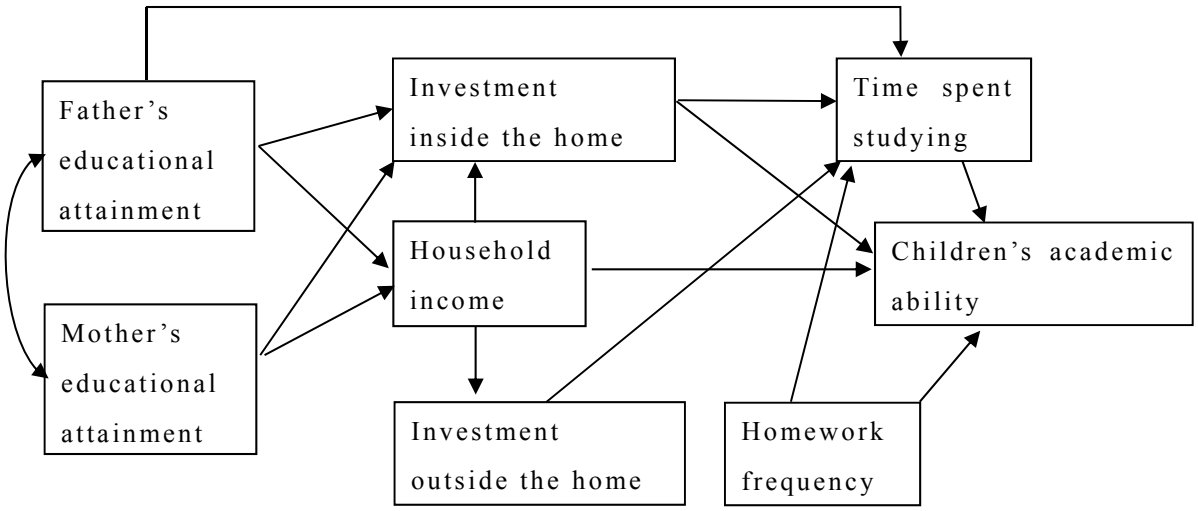


Figure 1. The model finally adopted (error terms omitted)

Next, for each of the individual groups, an analysis was conducted for a model that allowed different coefficients for the paths (the arrows within the figure shown above; a model that did not impose equality constraints on the path coefficients). The results of this analysis for the goodness of fit indexes were GFI = .975, AGFI = .930, CFI = .942, and RMSEA = .039. In the multiple population analysis, through a comparison of the model not imposing equality constraints on the assumed population parameters with the model that did impose equality constraints, an investigation was carried out to ascertain where differences existed between the groups. In this research, a comparison was made between (1) the model that imposed absolutely no equality constraints on the relationships between variables (the no-constraints model), (2) the model that imposed equality constraints on all the relationships between all variables (the "all-constraints model"), and (3) the model that imposed equality constraints only on the relationships between some of the variables (the "partial-constraints model"). The partial-constraints model was created while referring to the results of the

hierarchical multiple regression analysis and the verification of the differences between estimated parameters (e.g., Kawabata, 2007). In the partial-constraints model ultimately used, the population parameters for which equality constraints were not imposed for the four path coefficients of the father's educational attainment and time spent studying, household income and children's academic abilities, investment outside the home and time spent studying, and household income and investment inside the home. Table 5 shows the values for the goodness of fit indexes for the no-constraints model, the all-constraints model, and the partial-constraints model.

Table 5 Goodness of fit for each model

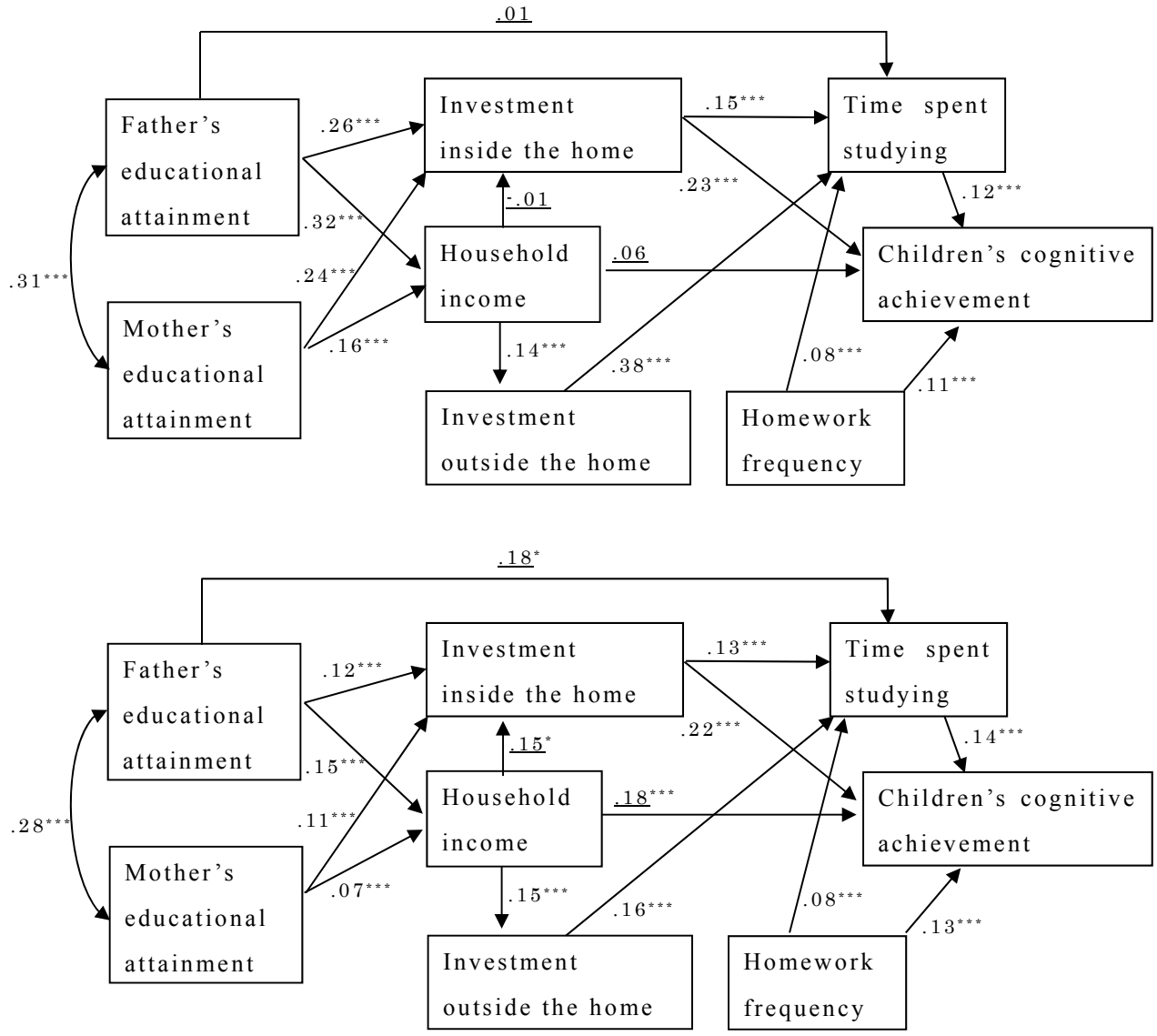
Model	*df*	GFI	AGFI	CFI	RMSEA	AIC
No-constraints model	26	.975	.930	.942	.039	133.15
All-constraints model	40	.965	.937	.926	.035	123.08
Partial-constraints model	36	.972	.944	.961	.027	118.18

Each of these three models showed a high goodness of fit with the data, but based on the AGFI values adjusted for a degree of freedom and the RMSEA values, it was concluded that the optimum model was the partial-constraints model. As well, AIC values indicated a goodness of fit appropriate for a comparison between models (Murohashi, 2003), albeit even in this sort of index of goodness of fit, the partial-constraints model showed the highest level of goodness of fit. Based on an overall judgment from these results, in this research the partial-constraints model was used; more precisely, the data supported the assumption that within the process by which family background affects children's academic ability, there are differences for junior high students and elementary students in the following relationships: between the father's educational attainment and time spent studying, between household income and children's academic ability, between investment outside the home and time spent studying, and between household income and investment inside the home.

For the partial-constraints model, Figure 2 shows the anticipated results for both elementary and junior high students. The values marked by an arrow are standardized coefficients and indicate the strength of the relationship between the variables. As can be seen from Figure 2, the results for both elementary and junior high students suggest that the father's and the mother's educational attainment mediate the variables of household income, investment inside and outside the home, and the amount of time the children spent studying, and thereby affect children's academic ability. Moreover, it suggests that in the relationship between the frequency with which schools allocate homework and children's academic ability, there is both an indirect effect that mediates time spent studying and a direct effect that does not

mediate time spent studying.

The underlined values within the figure are the path coefficients that appear to differ between elementary schools and junior high schools. The direct relationship between household income and academic ability demonstrated significance for junior high students, but no significant correlation was observed for elementary students. In addition, for junior high students, significant correlations were observed between the father's educational attainment and amount of time the children spent studying and household income and investment inside the home; for elementary students, however, these significant relationships were not observed. Conversely, in the relationship between investment outside the home and time spent studying, the data suggested a stronger correlation for elementary students than for junior high students.



*p < .10, **p < .05, ***p < .01

GFI = .972 AGFI =.944 CFI =.961 RMSEA =.027 AIC = 118.18

Figure 2. Estimated results for elementary schools (upper figure) and junior-high schools (lower figure)

Note: The numerical values are standardized coefficients (error terms omitted). The underlined values are coefficients that appear to be different between groups.

Section 5 Interpretation of the Results

In this research, we investigated the process by which social and economic factors within households, such as parents' educational attainment and income, affect children's academic ability, while also considering the role of various mediate variables. At the same time, we explored the possibility that the relationships between the variables are different for elementary students compared to junior high students.

Below, the relational processes between variables found to be shared by elementary and junior high students are considered and in addition, any differences observed between these two groups are discussed.

(1) Processes shared by both elementary and junior high students

(i) Effects mediated by investment in education

The results showed that for both elementary and junior high students, the father's educational attainment and the mother's educational attainment affect investment inside the home. Closely connected to this, the results also suggest that investment inside the home mediates time spent studying to affect children's academic ability. The scores for investment inside the home used in this research were calculated as weighted composite scores from answers to questions on the number of books within the home and whether or not these homes had Internet access, arts, musical instruments, a study room, and a study desk. It can be inferred that parents with a high educational attainment typically provide their children with a home environment that includes Internet access, arts, musical instruments, and a large number of books, all of which enable children to come into contact with a wide range of information during their daily lives. Such parents would tend to prepare an environment where their children can concentrate on their studies, such as a study room or a study desk. It is reasonable to assume that preparing this sort of home environment conducive to study may increase the amount of time children spend studying, which results in an improvement in their academic abilities.

In addition, it was found that there was a direct relationship between investment inside the home and children's academic ability that does not mediate time spent studying. This suggests that some children have access to

a wealth of cultural and information resources during their daily lives, which augments their academic ability.

Moreover, the results suggest that for both elementary and junior high students, the parents' educational attainment mediates household income to affect investment outside the home. Further, a statistically significant correlation was observed between investment outside the home and the amount of time children spent studying, which indicates that investment outside the home mediates the amount of time children spent studying and thereby affects the children's academic abilities. The following process can be inferred from the scores for investment outside the home: Regarding the total money parents invested in fees for after-school activities, the greater the amount invested in after-school activities (e.g., cram schools and home tutors), the more time a child spends studying outside of school, which improves his or her academic ability.

(ii) The effects generated by schools' allocation of homework

The results of a multiple regression analysis showed that for junior high students, there was a significant correlation between homework frequency and time spent studying, but from the SEM-estimated results, for both groups the correlation between these variables was only marginally significant. These results suggest a sequential process in which the homework allocated by schools increases the time children spend studying in their daily lives, which affects their academic ability. However, in this research, homework frequency was also observed to have a direct effect on children's academic abilities. In the JCPS, the respondents were asked, "How much time do you spend studying each day after you have returned home from school?" Therefore, the time the children spent doing homework during break time between classes or at school after classes was not included in the "time spent studying" totals used in this research. It is likely that when children completed their homework at school, it affected their academic ability without mediating the "time spent studying" variable. Consequently, it is possible that a direct relationship exists between homework frequency and academic ability. Finally, while it was not possible to identify it in the current framework, it is difficult to deny the possibility that causality exists in the opposite direction, in which the more that schools skillfully cooperate

with homes in improving children's academic ability, the more homework they are able to allocate to them and thereby simultaneously further improve children's academic ability.

(2) Differences between elementary and junior high students

The result of the SEM multiple population analyses suggested that differences may exist between elementary and junior high students for the following relationships: between the father's educational attainment and time spent studying, between household income and children's academic ability, between investment outside the home and time spent studying, and between household income and investment inside the home.

A path coefficient showing significance was not obtained in elementary schools for the relationship between the father's educational attainment and amount of time the children spent studying, but a significantly positive relationship was obtained for junior high schools. It can be thought that this result relates to the values given to children's study. In past research, those children who actively engage in study and value it to the extent that they made comments such as "Study is necessary to find a good job" and "for my life in the future," tend to be high academic achievers (e.g., Bong, 2001; Pintrich & De Groot, 1990). It is also believed that when the father's educational attainment is high, children are more likely to recognize the value of studying and therefore to increase the time they spend doing it. When considering research that has reported a decline in children's motivation to study during the period from elementary school to junior high school (e.g., Oie & Fujie, 2007), it can be said that effects demonstrated by the father's educational attainment tend to manifest themselves once the child becomes a junior high student.

In addition, in this research a difference was observed between junior high students and elementary students in terms of the effects that household income has on investment inside the home. It could be extrapolated that when the child becomes a junior high student, the parents invest more in his or her learning within the home than when in elementary school, such as providing each child with his or her own study room (please refer to the Appendix); granted, the higher the parents' household income, the more they are able to pay for this kind of investment. Naturally, it may be conjectured

that it was for this reason that a significant relationship was observed between household income and investment inside the home for junior high students.

Still of importance, with regard to differences in the effects that household income had on children's academic ability, a limitation of this research could entail the problem involved in measuring investment inside the home. When investment inside the home was measured in JCPS, the measurement items used assessed whether the home had Internet access, musical instruments, arts, a study room, or a study desk, as well as the number of books within the home. However, it is possible to imagine a variety of other investments in resources that would influence children's academic ability. For example, perhaps higher household incomes will mediate purchases of items such as study reference books and learning-related computer software that function to improve children's academic ability. It can be assumed that if parents decide to buy their children study reference books and learning-related software when they become junior high students, the direct effect that household income will have on children's academic ability will be seen only for junior high students. However, it is possible that the variables the authors were required to use in this research were not able to fully capture these effects.

Of interest, the results of this research suggest that the effects of the variable of investment outside the home (relating to money spent on fees for after-school activities) on time spent actually studying is different for junior high students versus elementary students. Then again, it can be thought that a problem exists in terms of how time spent studying is measured in JCPS. In JCPS, the time children spend studying outside of school includes time spent at cram schools and with home tutors. At elementary schools, it is possible that after-school activities are carried out many times for an inexpensive, one-time payment, such as lessons in using the Japanese *abacus*; in contrast, at junior high schools, after-school activities are carried out a small number of times with a high one-time fee, such as for cram schools and home tutors. Hence, if in this way the nature of the study-related after-school activities that elementary and junior high students engage in are different, it can be considered that at elementary schools, the amount spent on after-school activities will have a major

influence on the amount of time the child spends studying outside of school—but that at junior-high schools, this influence will be diminished.

Section 6 The Limitations of This Research and Prospects for the Future

First, since in this research there were no longitudinal data from an identical sample, it is not possible to predict the causal relationships between the variables using the timing of the observations. Of course, the models were constructed for variables for which it is difficult to envisage, either practically or theoretically, a reverse causality, such as for parents' educational attainment and household income, or household income and investment in education. It is not possible to investigate whether reverse causality existed between the variables of academic ability and homework; rather, it is feasible to project that "the higher the abilities of the learner, the more homework that the teacher is able to give." In previous research, it was reported that the more the learners demonstrated self-efficacy (which is an attitude of "I will strive to achieve better results"), the more actively they engaged in learning activities (e.g., Pintrich & De Groot, 1990). This finding suggests that the better the study results achieved by the learners, the higher their self-efficacy toward learning; as a result, they spend more time studying on a daily basis. Also of note, for the same reason, we were unable to find a clear answer to the question of whether the differences between elementary and junior high students that were observed in this research were due to changes in the influence that family background had on students for each academic year, or whether they originated from differences between the simple samples.

Further, when considering the trade-off between the number of siblings and investment in education (e.g., Hanushek, 1992), and also the differences in price levels between regions (Ministry of Finance, 2011), it is possible that the relationships between the variables might be different than those found in this research, depending on the number of siblings and the region in which they live. We believe that these points should be continuously surveyed via JCPS and then investigated at the point where a sufficient amount of longitudinal data has been accumulated.

Also key to this research, to investigate the effects that parents' educational attainment and income have on children's academic ability, analyses were conducted on investment in education both inside and outside the home as variables mediating the amount of time that children spend studying. Regrettably, the data acquired from the questions currently used in the JCPS questions on these variables is far from satisfactory as accurate measures for them. For example, in JCPS, the establishment of a home environment was measured via such variables as whether the home had Internet access, books, a study room, or a study desk. From another viewpoint, in addition to these variables, it is possible to envisage many other variables that will affect the child's academic ability, as for example the parents purchasing computer software for learning. Even though household income was found to have a direct influence on junior high students' academic abilities, it could be argued these results suggest that household income may have affected children's academic ability through investment in items other than those considered in this research. On this point, research in the future will need to be conducted while measuring a range of variables relating to investment in education other than those used herein.

Beyond what was previously stated, in JCPS the only values used to measure investment in education outside the home were the amount spent on fees for after-school activities. However, when using these types of measurement variables, the influence of the number of times that the child engages in after-school activities per week cannot be separated from monetary amount spent on after-school activities. As a result, it is not possible to ascertain whether expensive non-school learning, such as attending cram schools or studying with home tutors, is the most important factor, or whether it is better to participate in many after-school activities, even if the one-time tuition fee is inexpensive. In order to clarify the reasons for the differences in the effects demonstrated by investment outside the home, in future research it would be necessary to separately measure spending on learning activities and the number of times the child participates in these learning activities.

Problems also remain with the method of measuring the time children spend studying outside of school. In JCPS, the time spent studying in

after-school activities relating to study, such as cram schools and home tutors, is included in time spent studying outside of school. Conversely, the time children spend studying independently at schools outside of classroom time is not measured. Researchers such as Kariya (2001) have pointed out that parents' social status affects children's academic ability through the amount of time they spend studying each day, but even so, in order to accurately measure the amount of time children spend studying other than in classes, it seems that the composition of the questions in the surveys investigating this variable will have to be reconsidered.

Finally, the importance of the quality of learning needs to be considered. When investigating children's academic abilities, it is necessary to think about not only the amount of time they spend studying each day, but also the quality of their study. In educational psychology, a body of research has been accumulated on "learning strategies" as an important factor in determining academic ability. (A review of this body of research will include Alexander, Graham, & Harris (1998); Ito (2009); and Shinogaya (2012).) Even within the process by which family background affects children's academic ability, it is possible that parents with a high educational attainment use their own experiences to pass on to their children effective learning strategies. Given this, when investigating the time a child spends studying each day, the focus needs to be placed not just on measuring the quantitative aspect of the amount of time he or she spends studying, but also the qualitative aspects, such as the content of the textbooks used or the precise technique of study. We believe that this should enable the process by which family background affects children's academic ability to be observed in more detail.

【References】

Adachi, K. (2006). *Tahenryou Data Kaiseki Hou: Shinri, Kyouiku, Shakaikei no tame no Nyumon*. Tokyo: Nakanishiya Press, (in Japanese).

Akabayashi, Hideo. (2010) "Baburu Keizai Igo no Gakko Kyoiku to Kyoiku Seisaku (School Education and Education Policy after the Bubble Economy," in Y. Higuchi and ESRI (eds.), *Rodo Shijo to Shotoku Bunpai (Labor Market and Income Distribution)*. Keio University Press, pp. 287-317, (in Japanese).

Akabayashi, H., Nakamura, R., Naoi, M., Shikishima, C., and Yamashita, J. (2011). “The Correlates of Children’s Academic Ability in Japan: Findings from Japan Child Panel Survey 2010, ”. in Y. Higuchi, T. Miyauchi, C. R. McKenzie and Keio University Joint Research Center for Panel Studies (eds.), *Kyoiku, Kenko to Hinkon no Dainamizumu (Dynamism of Education, Health, and Poverty)* , Keio University Press, pp. 89–113, (in Japanese).

Akabayashi, H., Nakamura, R., Naoi, M., Yamashita, J., Shikishima, C., and Shinogaya, K. (2013) “Children’s Academic Ability and Family Background：Findings from the Japan Child Panel Survey 2011. Discussion Paper. Keio University.”

Alexander, P. A., Graham, S., and Harris, K. R. (1998), . “A perspective on strategy research: Progress and prospects.” *Educational Psychology Review*, 10, 129-154.

Baron, R. M., and Kenny, D. A. (1986), “The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations.” *Journal of Personality and Social Psychology*, 51, 1173-1182.

Becker, G.S. (1991), *A Treatise on the Family*. Enlarged Ed. Harvard University Press.

Bong, M. (2001), . “Role of self- efficacy and task-value in predicting college students‟ course performance and future enrollment intentions.” *Contemporary Educational Psychology*, 26, 553-570.

Cunha, F. and J. J. Heckman. (2008), “Formulating, Identifying and Estimating the Technology of Cognitive and Noncognitive Skill Formation,”*Journal of Human Resources* 43 (Fall), pp. 739-780.

Hanushek, E. A. (1992), “The trade-off between child quantity and quality.” *Journal of Political Economy*, 100, 84-117.

Ichikawa, S. (2002). *Gakuryoku Teika Ronsou*. Tokyo: Chikuma syobou, (in Japanese).

Ito, T. (2009). Jiko *Chousei Gakusyu no Seiritsu Katei: Gakusyu Houryaku to Doukiduke no Yakuwari*. Tokyo: Kitaoji syobou, (in Japanese)

Kariya, T. (2001). *Kaisouka Syakai Nippon to Kyouiku Kiki: Hubyoudou Saiseisan kara Iyoku Kakusa Syakai*. Tokyo: Yushindou koubun sya, (in Japanese).

Kariya, T. (2008). *Gakuryoku to Kaisou: Kyouiku no Hokorobi wo dou Syusei suruka,* Tokyo: Asahi Shimbun Press, (in Japanese).

Kariya, T. & Shimizu, K. (2004). *Gakuryoku no Syakaigaku*. Tokyo: Iwanami Syoten, (in Japanese).

Kawabata, K. (2007). Tabosyudan Douji Bunseki. in Toyoda, H. (Ed) *Kyoubunsan Kouzou Bunseki*: AMOS hen (pp.74-87), Tokyo: Tokyo tosyo, (in Japanese).

Kline, Rex B. (2010). *Principles and Practice of Structural Equation Modeling*. 3rd. Ed. Guilford Press.

MacKinnon, D. P., Fairchild, A. J., and Fritz, M. S. (2007), "Mediation analysis." *Annual Review of Psychology*, 58, 593-614.

Mimizuka, H. (2007). Gakusyu Jikan no Kaihuku: Yutakana Manabi ni dou Tunageru ka. VIEW21, 3, pp6-9., Tokyo: Benesse Cooporation (in Japanese).

Murohashi, H. (2003). Bunseki no Yosa wo Hyouka suru. in Toyoda, H. (Ed) *Kyoubunsan kouzou bunseki: Gimon hen* (pp.120-127). Tokyo: Asakura syoten, (in Japanese).

Pintrich, P. R., and De Groot, E. V. (1990). "Motivational and self-regulated learning components of classroom academic performance." *Journal of Educational Psychology,* 82, 33-50.

Spencer, J. S., Zannna, M. P., and Fong, G. T. (2005). "Establishing a causal chain: Why experiments are often more effective than mediational analysis in examining psychological processes." *Journal of Personality and Social Psychology*, 89, 845-851.

Iwaki, H. (2004). *Yutori Kyouiku kara Kosei Rouhi Syakai he*. Tokyo: Chikuma syobou, (in Japanese).

Oie, M. & Fujie, Y. (2007). Syougakkou kara Chugakkou he no Ikouki ni okeru Risuka no Doukiduke. Research Center for Child and Adolescent Development and Education, Ochanomizu University, 4, 75-81, (in Japanese).

MEXT (2008). *Tyugakkou Gakusyu Sidou Youryou: Sousoku hen.* Tokyo: Gyousei, (in Japanese).

Ministry of Finance (2011). Heisei 22 Nen Heikin Syouhisya Bukka Tiikisa Sisu no Gaikyou<http://www.stat.go.jp/data/cpi/sokuhou/chiiki/pdf/chiiki.pdf>, (in Japanese).

Shimizu, K. (2005). *Gakuryoku wo Sodateru*. Tokyo: Iwanami shinsyo, (in Japanese).

Shinogaya, K. (2008). Effects of preparation on learning: Interaction with beliefs about learning. *Japanese Journal of Educational Psychology*, 56, 256-267, (in Japanese).

Shinogaya, K. (2012). Learning strategies: A review from the perspective of the relation between learning phases. *Japanese Journal of Educational Psychology*, 60, 92-105, (in Japanese).

【Appendix】

	Father's educational background		$\chi^2(1)$	Mother's educational background		$\chi^2(1)$
	University graduates	Non-university graduates		University graduates	Non-university graduates	
Elementary students	94	109	0.77	36	167	1.16
Junior high students	73	116		26	163	

	Internet		$\chi^2(1)$	Paintings		$\chi^2(1)$	Musical instruments		$\chi^2(1)$
	Have	Have not		Have	Have not		Have	Have not	
Elementary students	168	35	0.49	32	171	1.40	139	64	3.21
Junior high students	158	31		32	167		113	76	

	No. of books						$\chi^2(5)$
	0	～10	～50	～100	～300	300～	
Elementary students	2	13	65	53	51	19	5.21
Junior high students	6	9	67	43	40	24	

	Study room			$\chi^2(2)$	Study desk			$\chi^2(2)$
	have not	share	have		have not	share	have	
Elementary students	26	78	99	6.65*	17	4	182	2.05
Junior high students	14	60	115		10	2	177	

	Homework frequency (day/week)				$\chi^2(3)$
	0	1～2	3～4	every day	
Elementary students	16	6	24	157	98.91**
Junior high students	35	50	49	55	

	Time spent studying (hours/day)							$\chi^2(6)$
	0	0.5	1	2	3	4	5	
Elementary students	26	44	72	33	19	9	0	22.04**
Junior high students	19	42	38	55	22	9	6	

Results of the principal component analysis for questions on investment inside the home

	principle component	
	Ⅰ	Ⅱ
No. of books	.733	-.259
Have/don't have paintings	.635	-.250
Have/don't have musical instruments	.591	-.387
Have/don't have Internet access	.377	.222
Have/don't have a study desk	.300	.762
Have/don't have a study room	.360	.737