

EFFECTS OF LITERACY ENVIRONMENTAL FACTORS
ON FOURTH GRADERS' MATHEMATICS-RELATED
OUTCOMES IN FINLAND

A Thesis Presented to
The Faculty of Graduate School
At the University of Missouri

In Partial Fulfillment
Of the Requirements for the Degree
Master of Arts

by
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MAY 2013

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EFFECTS OF LITERACY ENVIRONMENTAL FACTORS ON FOURTH GRADERS' MATHEMATICS-RELATED OUTCOMES IN FINLAND

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ACKNOWLEDGEMENTS

Foremost, I would like to thank to my advisor, Dr. Ze Wang for her limitless help and supports through learning process of this master thesis. Her feedback and guidance enabled me to develop an understanding of the subject. Without her patient guidance and dedication, this thesis would not have been possible.

I also would like express my deepest gratitude to my other committee members, Dr. Steven Osterlind and Dr. Duane Rudy for their invaluable feedback and timely suggestions during preparation of my thesis.

I am grateful to my husband, Sejung Kim. He has always encouraged me and made me happy.

This work is dedicated to my parents, Hee-Jung Seo and Joo-Myung Kim, who give their complete love to me through my whole life.

Lastly, I thank God for everything.

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EFFECTS OF LITERACY ENVIRONMENTAL FACTORS ON FOURTH GRADERS' MATHEMATICS-RELATED OUTCOMES IN FINLAND

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ABSTRACT

According to many researchers, literacy affects not only students' reading achievement, but also achievement in diverse subjects. To increase students' academic outcomes, as one of the ways to explain how to develop literacy education, many education researchers have focused on environmental factors supporting literacy education, primarily in the student's home.

This study examined the effects of literacy environmental factors at home on students' academic achievement, self-concept, and attitude toward mathematics. The data used in this study were from Finland at the fourth grade level in the Trends in International Mathematics and Science Study (TIMSS) 2011 and the Progress in International Reading Literacy Study (PIRLS) 2011.

Multiple regression analyses were performed for each dependent variable. The six independent variables which are parents' involvement in literacy learning, parents' highest level of education, early literacy education environment, the number of books, material sources, and students' gender together accounted for approximately 24% of variance in academic achievement in mathematics and affected mathematics academic achievement significantly based on the t statistics for regression coefficients. Early literacy education, parents' involvement in students' literacy learning, parents' highest level of education, the number of books, and students' gender accounted for

approximately 8.7% of the variance in students' self-concept in mathematics. In the last analysis, only early literacy education environment and students' gender were significant to predict students' attitude toward mathematics with 1% of the variance.

In this study, literacy education environmental factors had effects on explaining and developing all of the dependent variables. Especially, the early literacy education variable and students' gender were used as significant predictors on all dependent variables. In the future study, including the early literacy education, other environmental factors such as SES, parental attitude toward reading which could have a strong relationship with students' outcomes should be explored.

CHAPTER 1 INTRODUCTION

The study of the importance of literacy education is a promising topic in the field of child development. According to many researchers, literacy affects not only reading achievement, but also achievement in diverse subjects, including mathematics (Glenberg, Willford, Gibson, Goldberg, & Zhu, 2012; Jordan, Hanich, & Kaplan, 2003). Therefore, this study describes the relationship between literacy education and mathematics outcomes and explains how to develop literacy education to increase academic outcomes. This research focuses on the measurement of the relationship between literacy ability and mathematics achievement in cognitive and affective domains. It is important to understand the relationship between reading and mathematics because reading ability can increase success in all academic subjects (Glenberg et al., 2012).

As an unintended consequence of the No Child Left Behind Act (NCLB), a number of students have difficulty solving mathematics problems from reading short passages, although they know the concept or skill required for the problem well (Friedland, McMillen, & del Prado Hill, 2011). In other words, when students obtain the incorrect answer in a mathematics problem, they might not be skilled readers and make errors such as including needless information about solution process. There is much evidence to support the strong correlation between reading and mathematics achievement. According to Jordan, Hanich, and Kaplan (2003), children who lack reading and math skills when they were second graders continue to show inaptitude in both skills after many years (Jordan et al., 2003). These researchers also demonstrated that an improvement in mathematical problem-solving was developed by improving reading skills.

In order to figure out the influence of literacy education on reading and other subject achievement, many education researchers have focused on environmental factors supporting literacy education, primarily the student's home. As for home environment, Bourdieu's (1973) cultural capital theory suggest that cultural and capital sources generated at home play an important role in the development of children's achievement. In addition, a cumulative advantage would result from these opportunities to have such sources and achievement. This is called the Matthew effect (Stanovich, 1986). In addition, parents' attitudes or habits at home influence children's attitudes toward reading, as children observe and interact with their parents (Bandura, 1986).

The objective of this study is to examine the literacy education environmental effects on students' cognitive and non-cognitive outcomes in mathematics. In other words, this study would clarify whether literacy environmental factors at home affect students' academic achievement, self-concept, and attitude toward mathematics. The study addresses specific research questions:

1. Do all home variables (early literacy education, parental attitude toward reading, the number of books, material sources, parents' highest level of education, parents' involvement in students' literacy learning, and students' gender) affect students' academic achievement in mathematics?
2. Do all home variables considered in this study influence students' self-concept in mathematics?
3. Do all home variables considered in this study have effects on students' attitude toward mathematics?

The data used in this study are from the Trends in International Mathematics and Science Study (TIMSS) 2011 and the Progress in International Reading Literacy Study (PIRLS) 2011; both are databases with representative large-scale cross-national data in the field of educational achievement. Data collected include information for improving students' learning in reading, mathematics and science from students, parents, teachers, and principals in 63 countries. In this study, students who are fourth graders residing in Finland and their parents participated. This study examined the relationship between different types of literacy education environmental factors and academic achievement with regard to mathematics in cognitive and affective (non-cognitive) domains.

Educational achievement in Finland has been identified by a variety of assessments. One of important assessments, the Program for International Student Assessment (PISA), of which the methodology access and the reading component part are influenced by TIMSS and PIRLS, respectively, administers the standardized test in three fields: reading, mathematics, and science. In 2009 Finland earned third place in reading and six place in mathematics among the Organization for Economic Cooperation and Development (OECD) nations, whereas the United States scored 17th and 26th places in reading and mathematics. Compared to the basic education system in United States, there are similarities from Finland. Especially, elementary school education system is similar, which has similar starting age of students and continues to six grades. In addition, both students from two countries learn various kinds of common context in similar curriculum. Therefore, the use of the Finland dataset will provide the right direction needed to better develop education in the United States.

This study is significant in three ways. First, this study explains the influences of literacy education on mathematics cognitive and non-cognitive outcomes. In earlier studies, literacy education generally has been linked with only reading achievement. Whereas the relationship between literacy education and reading achievement is clear, the relationship between literacy education and mathematics (both cognitive and non-cognitive) achievement is unknown, so findings about its relationship with mathematics extends the field of academic achievement. Second, this study demonstrates the effects of literacy education on not only cognitive achievement in mathematics, but also on non-cognitive achievement in mathematics. In other words, the dependent variables are predicted into two categories, cognitive and affective domains. Third, literacy education is defined based on home environmental factors. Therefore, the significance of literacy education provides the important information as to which environmental factors students and parents need to develop positive mathematics outcomes.

The subsequent chapters unfold as follows. In chapter 2, the relationships between literacy skill and reading outcomes and mathematics outcomes are explained, and cognitive and non-cognitive variables to assess mathematics outcomes are reviewed. The factors related to home literacy education environment are also explained. In chapter 3, the dataset used in this study is described, and the research design is explained with variables. In chapter 4, the results of findings that influence literacy education environmental factors at home are demonstrated. Lastly, in chapter 5, the summary of this study's findings and the future direction and limitations of this study are explained.

CHAPTER 2 REVIEW OF THE LITERATURE

There are a great number of studies that have investigated the relationship between literacy education and students' academic achievement (e.g., Freedman, 1997; Hemmings, Grootenboer, & Kay, 2011; Kush, Watkins, & Brookhart, 2005; Stuart & Masterson, 1992; Thurber, Shinn, & Smolkowski, 2002; Wells, 1982). The results of these studies expressed a strong and positive association between literacy education and students' academic achievement. Therefore, many researchers pay attention to the role that literacy education plays in developing children's academic improvement.

This chapter consists of four sections. The first section explains literacy education and reviews the relationships between literacy education and reading and mathematics achievement. The second section reviews assessments of mathematics achievement related to Bloom's Taxonomy of learning domain theory (Bloom, 1956). The third section reviews environmental factors of home to improve literacy education. The last section is summary of this chapter.

2.1 Literacy Education

Literacy is defined many ways from different points of view. As Searfoss, Readence, and Mallette (2001) explained: "Literacy means being able to communicate through reading and writing. It requires the acquisition of reading and writing skills and the ability to apply those skills in interactions with others in a variety of contexts" (p.4). As this definition demonstrates, children absolutely need literacy skills, not only to learn across all academic subjects, but also to live with others. In this study, the importance of literacy skills on only academic subjects is described.

The skill of reading is regarded as a rudimentary form of literacy (Searfoss, Readence, & Mallette, 2001). Moreover, when children learn various types of subjects, reading is one of the most influential abilities to get information (Glenberg et al., 2012). In other words, most academic courses such as English and mathematics need reading skills to create knowledge. Another factor of literacy, the skill of writing, also plays an important role on learning academic subjects. Writing helps students to reflect their thoughts from inner language and develop their ideas logically.

2.1.1 Relationship between Literacy Skill and General Reading Outcomes

One important reason why literacy is an obvious variable is that literacy has an impact on reading achievement. This relationship has been demonstrated in a number of longitudinal and experimental studies (Kush et al., 2005; Manning & Manning, 1984; Stuart & Masterson, 1992; Wells, 1982). The more children are exposed to literacy education, the more they have opportunities to have reading experiences, and then these opportunities lead to getting better at reading. Even though the effect of literacy education does not show at first, it turns out to be a salient source of reading achievement as time goes by (Kush et al., 2005).

Pre-school children who receive literacy education from their parents are more likely to achieve better reading marks when they go to school (Wells, 1982). In addition, if children are prepared to read letters and learn the meaning of the letters before starting school, they are more likely to become good readers later (Stuart & Masterson, 1992). Furthermore, among literacy education instructions for young students, recreational

reading is considered as an important descriptor affecting reading academic achievement and reading attitude (Manning & Manning, 1984).

2.1.2 Relationship between Literacy Skill and Mathematics Outcomes

Some people think that the language of mathematics is different from the general language we use in our daily lives and is only used in classes. One of the reasons is because there are many words in mathematics that have different meanings from ordinary language, such as *power* or *radical*. Therefore, it is common to doubt that a relationship exists between literacy based on ordinary language and Mathematics. However, although there are different meanings for the same words, literacy skills such as reading and writing play a central role in developing academic knowledge (Casteel & Isom, 1994).

Using literacy skills such as reading and writing, students create knowledge, comprehend the physical or abstract world, and develop mathematics achievement. According to Friedland et al. (2011), NCLB has highlighted that a number of students have trouble in solving mathematics problems from reading and writing inaptitude, although they comprehend the mathematics concept. From their experiments, they demonstrated that students who lack literacy skills would make a mistake, such as including irrelevant information for solving a problem.

Thurber, Shinn and Smolkowski (2002) clearly stated the relationship between reading and mathematics achievement. They found the correlations between reading and mathematics computation and between reading and mathematics application are .69 and .76, respectively. They concluded that the improvement in mathematics skill is mediated by literacy ability.

In addition, the National Council of Teachers of Mathematics (NCTM) supported the importance of writing in mathematics. Since students' writing activity in mathematics requires them to clarify their thoughts, it is considered an effective way to develop mathematics achievement. Similarly, communicating with peers, teachers, or parents based on literacy skills such as reading and writing also has significant influences on clarifying and developing mathematics learning (NCTM, 2000).

2.2 Assessing Cognitive Achievement and Affective Outcomes in Mathematics

One of the most influential theories to assess learning outcomes is the Bloom's Taxonomy of learning domain theory (Bloom, 1956). Bloom classified the child education assessment field into three domains of educational activities: cognitive, affective, and psychomotor. The cognitive domain is what people think of as general academic achievement and is composed of six subdivisions, which are knowledge, comprehension, application, analysis, synthesis, and evaluation. In terms of the affective domain, there are five subdivisions, which are receiving, responding, valuing, organization, and characterization by a value or value complex (Krathwohl, Bloom, & Masia, 1973), and self-concept and attitude are examples of current research on paying attention as important outcomes of schooling (Brookover, Thomas, & Paterson, 1964; Enemark & Wise, 1981; Marsh & Craven, 2006; Marsh & O'Mara, 2008; Steinkamp, 1982; Suydam & Waver, 1975). The psychomotor domain, which requires practice to develop, is usually linked with physical movement (Simpson, 1972). This domain is explained with the seven categories: perception, set, guided response, mechanism, complex overt response, adaptation, and origination.

2.2.1 Academic Achievement, Self-concept, and Attitude

The cognitive variable has relevance to assessing academic background and academic outcomes and is measured as standardized test scores or GPA. In general, academic achievement, which is the visible result of learning by examination, is used as a representative factor of the cognitive domain.

In terms of the affective domain, Krathwohl et al. (1973) explained that it is another type of learning outcome related to emotions. Although cognitive abilities of students are normally referred to as a primary factor for predicting academic achievement, recent research has focused on affective influences as well. “Self-concept” is defined as “the individual's conception of himself emerges from social interaction and, in turn, guides or influences the behavior of that individual” (Kinch, 1963, p. 481). Self-concept is regarded as one of the important variables, not only in the field of motivational research, but also in assessing affective domain (Marsh & Craven, 2006).

Although self-concept is conceived as a generalization of confidence in learning subjects, attitude describes the belief about the certain subjects (Reyes, 1984). Attitude toward academic subjects is generally another important factor of the affective domain. “Attitude” is defined by Aiken (1970a) as “a learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept, or another person” (p. 551).

2.2.2 Relationship between Academic Achievement and Self-concept

One example of an affective variable, self-concept of students, is measured as the adaptation state of school, which is also associated with academic achievement. That is

the reason why there are a great number of studies in terms of explaining the strong association between self-concept and achievement (Brookover, Thomas & Paterson, 1964; Muijs, 1997). According to Brookover et al. (1964), there is a positive and significant correlation between self-concept of ability and academic performance even when IQ is controlled. When academic self-concept is high, academic achievement is also high, as well as intrinsic motivation. In this regard, Branden (1994) demonstrated that the research for improving academic self-concept should be more studied in the fields of education and child development.

In mathematics, there is a positive relationship between self-concept and achievement from a study that examined 16 countries (Wilkins, Zembylas, & Travers, 2002). Self-concept of ability turns out to be a significant variable about mathematics achievement in four different countries (Wang, Osterlind, & Bergin, 2012). It demonstrates that especially a self-concept variable in mathematics has stronger effects to account for mathematics achievement than English or science subject. In the same study, the authors had no evidence that there is a causal relationship between self-concept and achievement in mathematics. However, they determined that there is a strong association from four selected countries, USA, Russia, Singapore, and South Africa.

2.2.3 Relationship between Academic Achievement and Attitude

In terms of another affective variable, which is attitude toward subjects, there has been well documented research about a causal relationship between academic achievement and attitude (Enemark & Wise, 1981; Steinkamp, 1982; Suydam & Weaver, 1975). In other words, the more students have interest or motivation toward the subject,

the higher the students' academic outcomes in the subject. According to McLead (1992), in mathematics education, attitude toward learning is an important variable of the affective domain. Similarly, Hemmings, Grootenboer, and Kay (2010) concluded that attitude toward mathematics is used as a salient variable to predict academic achievement in mathematics as well. Attitude toward learning mathematics has an impact on mathematics achievement (Enemark & Wise, 1981; Dossey, Mullis, Lindquist, & Chambers, 1988; Steinkamp, 1982). In this regard, when addressing the positive correlation between positive attitude toward mathematics and mathematics achievement, Suydam and Waver (1975) demonstrated that continual efforts to develop positive attitudes are needed for improving mathematics achievement. Therefore, attitude toward mathematics is a major factor for the education field and is linked with academic achievement.

2.3 Environmental Factors to Develop Literacy Education

In order to provide students literacy education effectively, the place where they can meet and use literacy should be considered significantly. The major place students meet about literacy can be in their home, where parents or guardians can provide not only structural materials but also opportunities to learn literacy skills such as reading or writing. The home environment plays an important role in establishing the foundation for early literacy and developing cognitive and non-cognitive domain variables such as reading skill, self-concept, and positive attitude toward literacy (Kennedy & Trong, 2010).

2.3.1 Cultural Capital Theory

According to the theory of cultural reproduction (Bourdieu, 1973), school values specific cultural capital from dominant stratum and makes reproduction of an unequal society with the cultural capital. He asserted that students who have much more of certain cultural capital are more likely to have academic achievement. In other words, education reproduces unequal results, which are that students who own cultural capital own success and those who do not own it fail. Bourdieu (1973) emphasized the importance of the role of language to reproduce certain cultures. Since language can be reflected by an individual's experience and thoughts, it has power to make differences for other groups. There are three different types of cultural capital he mentions: internalized, objectified, and institutionalized cultural capital.

Internalized cultural capital with early literacy education. The internalized cultural capital means sophistication and habitus a person has. Students can accumulate and internalize the internalized cultural capital by doing activities called sophistication or culture by hand, and the cultural capital leads them to academic achievement. Such internalized cultural capital can form when students are exposed to environmental abundance of cultural capital, not acquired through cramming students' head with knowledge. Bourdieu (1973) especially stressed that internalized cultural capital is influenced by cultural capital owned by family and influences individual children.

This theory seems to correlate with an aspect in early literacy education. Many studies have found the influence of early literacy education to later academic achievement, and early literacy education is considered as a significant issue in child development, and also many educators and schools are focusing on the way to develop

this issue. What is absolutely necessary for early literacy education is parents' help and support of their children. In this context, literacy education can be interpreted as specific cultural capital, and the cultural capital possessed by family can be expressed as parents' help and support. A number of studies found that there is a relationship between the parents' behavior, such as reading to a preschool child, and not only the child's reading scores later, but also spoken language development and predicting subsequent reading marks (Clay, 1979; Wells, 1982; Whitehurst, Falco, Lonigan, Fischer, DeBaryshe, Valdex-Manchaca, & Caulfield, 1988). In addition, the given opportunities in the home environment to participate in literacy activities or prepare reading skills lead children to become competitive readers (Duncan, Claessens, Huston, Pagani, Engel, Sexton, et al., 2007; Stanovich, Cunningham, & Cramer, 1984). Mullis, Martin, Kennedy, and Foy (2007) described home environment, which is based by family cultural capital, as showing long-lasting effects on reading achievement and attitude toward reading.

It is obvious that students who experience early literacy education sufficiently have more opportunities to get successful reading achievement. Such reading achievement coming from ample early literacy experience generates another reading achievement. There has been plenty of evidence from longitudinal and empirical studies about a positive correlation between early literacy achievement and later reading achievement (Kush et al., 2005; Snow, Burns, & Griffin, 1988). Most children who are poor readers in sixth grade have failed to gain literacy skills before starting school (Snow et al., 1988). Similarly, with using results (98.6% of the variance) from structural equation modeling (SEM), Kush et al. (2005) concluded that children's seventh-grade reading achievement is explained by early reading achievement. Based on these results,

Stanovich (1986) examined the “Matthew effect,” which means that the more students have opportunities to have reading achievement, the better chance of success they will have. In other words, students who have more literacy experience with successful attainment can also have more advantage to attain successful achievement.

Internalized cultural capital with Vygotsky’s zone of proximal development. Bourdieu’s cultural capital theory is linked with the Zone of Proximal Development (ZPD) developed by Vygotsky (1978). The ZPD has been defined as “ the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers” (Vygotsky,1978, p. 86). This can be understood as internalized cultural capital is construed as children’s academic development and cultural capital owned by family is as parents’ guidance to help children’s academic development. The parents’ guidance can be called parents’ involvement in students’ learning, which is helping school work or homework, setting aside time to help with children’s homework, asking what their children learned, and talking with children about what they read. The effects of parents’ involvement in students’ learning has been studied. Keith et al. (1998) indicated that parent involvement has an important effect on tenth grader’s learning, and there are no differences on gender and ethnic group. McWayne et al. (2004) also explained that parents’ involvement has a positive effect on students’ reading and mathematics achievement. Barnard (2004) demonstrated that parents’ involvement has an impact on elementary students’ academic performance.

Internalized cultural capital with Bandura's social learning theory. Bourdieu's cultural capital theory is also explained by associating Bandura's (1986) Social Learning Theory, which addresses how current behaviors are decided by personal and environment variables. This can be applied so that internalized cultural capital is construed as children's attitude and intrinsic motivation toward reading and literacy, and cultural capital owned by family is as parents' attitude toward reading and literacy. The effect of parents' reading habit or attitude on children's reading motivation has been well documented (Baker & Scher, 2002; Csikszentmihalyi, 1991; Neuman, 1986), and the results show that parents' reading habits are influential in children's education performance. In order to build children's reading habits, parents' direct and indirect encouragement plays a central role (Neuman, 1986). One of the ways parents can be encouraging is by showing the importance of reading books and having a positive attitude toward reading. Through parents' behavior, children recognize the significance of reading and simultaneously the fact that reading is capital, which the dominant class regards as important; as a result, they decide to behave positively toward reading. Csikszentmihalyi (1991) demonstrated that when children observe their parents' enjoyment with reading books, they value a reading habit and imitate the behavior. According to Baker and Scher (2002), students whose parents have positive attitude toward literacy are more likely to have higher reading motivation, which is the most salient factor for achievement.

Internalized of cultural capital with socioeconomic status (SES). In general, the SES that is composed of the household income, parents' education, and their occupation is also associated with the internalization of cultural capital. Numerous studies found the

academic performance differences from different SES families (Duncan, Brooks-Gunn, & Klebanov, 1994; Neuman, 1996). Using one-way ANOVA, when comparing children's reading achievement by parents' social class, which are middle and working classes, the results confirmed that students who are in a higher socioeconomic class have higher academic performance than those in lower socioeconomic class (Stuart, Dixon, Masterson, & Quinlan, 1998). According to Neuman (1996), because of sufficient experiences such as sharing story books with their parents, differences from the different level of SES, compared to children in lower SES classes, children who are in middle and high classes are more likely to consider literacy as entertainment. The positive attitude toward literacy is an important factor to improve both academic achievement and intrinsic motivation.

Heyneman and Loxley (1982, 1983) examined children's academic ability with respect to SES. They divided countries into two groups, advanced country and developing country. According to the results of this study, in an advanced country, a SES factor has a stronger effect on academic performance than a school factor; whereas, in a developing country, the converse is true. In their study, overall national economic level also played a significant role on the influence on academic achievement of children.

However, there are negative views in terms of SES effects on academic achievement (Scher & Baker, 1996; Park, 2008). Scher and Baker (1996) concluded that there is a positive relationship between home environment and reading motivation of children regardless of the SES level. In addition, using respondents from 25 countries, Park (2008) emphasized that home atmosphere toward literacy is a more significant factor to achieve academic attainment of children rather than the difference of SES.

Concerning the relationship between the SES level and academic marks, there is great diversity of opinion. Therefore, the influence on achievement will be studied with well-measured tools, controlled variables.

Objectified cultural capital. The objectified cultural capital is cultural goods such as books, pictures, and tools. What is interesting about the objectified cultural capital is that although a person possesses such objectified cultural capital, it is not a meaningful capital unless he or she knows how to use the objectified cultural capital with an internalized one (Bourdieu, 1973). In other words, the objectified cultural capital proved to be worthwhile when it is used by people who already prepared for the internalized cultural capital. In spite of the fact that the role from only objectified cultural capital seems to be a small effect, in order to use such objectified cultural capital based on the internalized one, it should be underpinned by economic capital (i.e., money).

One of the decisive factors related to this cultural capital to predict students' achievement is the number of books children read (Wobmann, 2003). Since children have more opportunity to read books at home rather than at the library, the number of books at home is a significant factor. Therefore, materials such as books and computer, depending on finance, are influential on achievement or motivation in literacy education as well.

Institutionalized cultural capital. Diploma and certificate are used as examples of institutionalized cultural capital. This capital is used as a standard in a society and symbolizes the ability of person. Based on the number of or level of this capital, it can generate differences of social status to people who own it.

2.4 Summary

In this chapter, the influence of literacy education on academic subjects such as English and mathematics is explained. The relationship between literacy education and reading is obviously significant. Although the effects of literacy education do not appear immediately, literacy education is an important factor to predict reading achievement. As for the relationship between literacy education and mathematics outcomes, it is found that there is a close affinity between them.

In order to explain mathematics cognitive and non-cognitive outcomes, the Bloom's Taxonomy of learning domain theory is used. According to Bloom's (1956) theory, the field of assessment is divided into three domains: cognitive, affective, and psychomotor. In the second section, the relationships between cognitive factor and affective factors are reviewed. Substantial effort has gone into study on the affinity between academic achievement and self-concept, and the result shows a positive and significant correlation even when controlling for IQ. Attitude toward each subject turns out to be a significant factor to explain academic achievement while showing a strong association between them.

In terms of environmental factors to improve literacy education, home is a typical example. In the third section, with linking with Bourdieu's cultural capital theory, some kinds of home environmental variables are presented and explained about its characteristic and consisting items.

CHAPTER 3 METHOD

This chapter includes three sections. The first section describes data source. The second section explains measures used in this study. The last section describes the analyses and software program used in this study.

3.1 Data

Data for the current study were from the Trends in International Mathematics and Science Study (TIMSS) 2011 and the Progress in International Reading Literacy Study (PIRLS) 2011. The TIMSS has been conducted every four years by the International Association for the Evaluation of Educational Achievement (IEA). The TIMSS 2011 measured trends in students' mathematics and science achievement and collected extensive information by surveying students, teachers, school principals, and curriculum experts from 63 countries and 14 benchmarking area. In student questionnaires some aspects of their home and school lives and self-perception and attitudes toward mathematics and science were included. In teacher questionnaires, teachers were asked about their education, professional development, teaching experience, and curriculum and instructional activities regarding both subjects. In addition, the principals of each school responded in school questionnaires, which consist of school characteristics, the capacity of resources, and environments for learning. In terms of curriculum questionnaires, curriculum experts responded about questions, which are about organization and content of the curriculum in both subjects (TIMSS 2011 User Guide for the International Database, p. 1).

The PIRLS which is another IEA's core cycle study has been conducted on a regular five years cycle. The PIRLS provide international students' reading achievement of the fourth grade to compare perspective trends in accordance with different educational environments of home and school and instruction ways. In the PIRLS 2011 database, 48 countries and 9 benchmarking participants were involved. Especially, the PIRLS 2011 carried out a home questionnaire called the Learning to Read Survey to the same sample of fourth grade students who are participants in the TIMSS 2011 research and the parents or guardians of each student. In this questionnaire, they are asked about preparations for primary schooling, children's activities such as reading books before attending schools, and parents' education level and job positions (PIRLS 2011 User Guide for the International Database, p. 1).

The particular data I used in this study were from Finland at the fourth grade level in TIMSS and PIRLS 2011. A total of 4594 students and their parents or guardians are included.

3.2 Measures

Students' achievement scores of mathematics were used as cognitive outcome variables and students' self-concept and attitudes toward mathematics were used as non-cognitive outcome variables. Home environmental factors are variables that tested the effects on children's cognitive and non-cognitive outcomes.

3.2.1 Outcome Variables

Students' achievement scores. One of the primary outcomes of this study is students' achievement scores. Since each student responded only one part of the entire pools of items in TIMSS, assessing precise estimates of each student' achievement is hard. Therefore, in TIMSS dataset to analyze and describe students' achievement more accurately, the item response theory (IRT) scaling was used and a multiple imputation methodology called plausible values were used instead of estimating students' achievement parameter.

Plausible values are random draws from the probability distribution with density $h(\theta|\mathbf{x})$. The mathematical process of $h(\theta|\mathbf{x})$ is as follows.

$$h(\theta|\mathbf{x}) = \frac{f(\mathbf{x}|\theta)g(\theta)}{\int f(\mathbf{x}|\theta)g(\theta)d\theta}, \text{ where } g(\theta) \sim N(\mu, \sigma^2)$$

\mathbf{x} : an item response pattern

θ : student achievement ability

$f(\mathbf{x}|\theta)$: item response probability model

$g(\theta)$: the population model

The achievement scores have a mean of 500 points and a standard deviation of 100 points. (TIMSS User Guide, p.13, 80-81).

Table 1

Means and Standard Deviations of Five Plausible Values in Mathematics

	M	SD
1 st Plausible Value	554.60	66.90
2 nd Plausible Value	545.38	68.50
3 rd Plausible Value	546.45	67.53

4 th Plausible Value	545.97	67.30
5 th Plausible Value	545.24	66.89

Self-concept. One of the non-cognitive domain variables is self-concept in mathematics. Students were asked to indicate how much they would agree about their self-concept in mathematics with four items using a 4-point Likert scale: disagree a lot (0), disagree a little (1), agree a little (2), and agree a lot (coded as 3). A sample item for this variable was “How much do you agree that you usually do well in mathematics?”. Since all items are positive statements, the responses were interpreted that a student’s high scores mean his/her high level of self-concept. Table 2 shows the means and standard deviations of each item for self-concept.

Table 2

Means and Standard Deviations of Students’ Self-concept Items in Mathematics

	M	SD
I am good at the subject	1.79	.94
I learn quickly in subject	2.23	.85
I usually do well in subject	2.25	.80
I am good at working out problems	1.71	.99

Attitude toward mathematics. Students’ attitude toward mathematics is another affective domain variable. Students responded to four items about students’ attitudes toward mathematics, which consist of a 4-point Likert scale. All items used in this study were comprised of positive statement and the response option was coded the same way in a self-concept variable, that is, higher scores represent higher level of attitude toward the subject. Sample item for attitude variable was “How much do you agree that you enjoy

learning mathematics?”. Table 3 shows means and standard deviations of each item for attitudes toward mathematics.

Table 3

Means and Standard Deviations of Students’ Attitude Items in Mathematics

How much do you agree that...	M	SD
You enjoy learning mathematics?	1.99	.96
You learn many interesting things in mathematics?	2.10	.96
You like mathematics?	1.87	1.10
It is important to do well in mathematics?	2.38	.83

3.2.2 Resources Variables at Home

Early literacy environment. Students’ parents or guardians were asked to indicate how often they provide their children with early literacy education experiences before their children go to school. Six items which are all positive statements measured the extent of children’s early literacy experiences using a 3-point Likert scale: never or almost never (0), sometimes (1), and often (coded as 2). Ranged from 0 to 2, the closeness of score 2 indicates the frequentness of early literacy activities at home.

Table 4

Means and Standard Deviations of Early Literacy Environmental Variables

Before your child began primary/elementary school, how often did you or someone else in your home...	M	SD
Read books with him or her?	1.74	.45
Tell stories to him or her?	1.20	.59
Play with alphabet toys with him or her?	.87	.63
Talk about what you had done with him or her?	1.77	.44
Talk about what you had read with him or her?	1.27	.58
Write letters or words with him or her?	1.32	.60

Parental attitude toward reading. In the home questionnaire, a parent or guardian also responded about the extent of interesting to read for assessing parental attitude toward literacy or reading books. All four items stated positively and were based on a 4-point Likert scale: disagree a lot (0), disagree a little (1), agree a little (2), and agree a lot (coded as 3). Sample item for this was “How much do you agree that you like to spend your spare time reading?”.

Table 5

Means and Standard Deviations of Parental Attitude toward Reading Variables

How much do you agree that	M	SD
You like talking about what you have read with other people?	2.11	.78
You like to spend your spare time reading?	2.19	.86
Reading is an important activity in your home?	2.00	.94
You enjoy reading?	2.56	.70

Parents’ involvement in students’ literacy learning. Parents’ involvement in students’ learning may range from attending a school event such as a school open house to helping children their academic activities such as homework. In this study, students’ parents or guardians were asked to indicate how much they are involved in children’s learning including literacy at home. Eight items with a 4-point Likert scale were used: never or almost never (coded as 0), once or twice a month (1), once or twice a week (2), and every day or almost every day (3). The items with means and standard deviations are Table 6.

Table 6

Means and Standard Deviations of Parents’ Involvement in Students’ Learning

How often do you or someone in your home...	M	SD
---	---	----

Discuss your child's schoolwork with him/her?	1.40	.60
Help your child with his/her homework?	2.08	.84
Make sure your child sets aside time to do his/her homework?	1.34	.72
Ask your child what he/she learned in school?	1.85	.81
Check if your child has done his/her homework?	1.77	.99
Help your child practice his/her reading?	3.07	1.03
Help your child practice his/her math skills?	2.56	.92
Talk with your child about what he/she is reading?	2.28	.84

The number of books and material sources at home. In this study, students responded in terms of the number of books at home which options were 0-10 books (coded as 1), 11-25 (2), 26-100 (3), 101-200 (4), and more than 200 (5). The mean and standard deviation of coded variables are 3.30 and 1.06, respectively. In addition, the items for explaining material sources were used such as the Internet connection, a student's own room, a study desk or a computer possession. Material sources variables were made by the dichotomous variables checking whether students possess the sources (1=yes, 0=no).

Table 7

Frequencies of the Number of Books at Home

	Frequency	Percent
0-10 books (1)	221	4.9
11-25 books (2)	673	14.8
26-100 books (3)	1873	41.2
101-200 books (4)	1064	23.4
More than 200 books (5)	719	15.8
Total	4550	100.0

Table 8

Frequencies and Means and Standard Deviations of Home Material Sources

Do you have...	Yes/ No Frequency	Yes/No Percent	Total	M	SD
A computer at your home?	4535/23	99.5/.5	4558	.99	.07

A study desk/table for your use at your home?	4181/369	91.9/8.1	4550	.92	.27
Books of your very own at your home?	4380/173	96.2/3.8	4553	.96	.19
Your own room at your home?	3718/832	81.7/18.3	4550	.82	.39
Internet connection at your home?	4361/182	96.0/4.0	4543	.96	.20

3.2.3 Additional Predictor Variables

Students' gender. This variable was coded as 0 = boy/male and 1 = girl/female. The number of participants was 4594, and the mean and standard deviation of students' gender were .49 and .50, respectively.

Parents' highest level of education. Using the International Standard Classification of Education (ISCED) developed by United Nations Educational, Scientific and Cultural Organization (UNESCO), in this study the education level of parents coded "No school" (coded as 1), "ISCED 1 or 2" (coded as 2), "ISCED 2" (3), "ISCED 3" (4), "ISCED 4" (5), "ISCED 5B" (6), "ISCED 5A, first degree" (7), "beyond ISCED 5A, first degree" (coded as 8). According to UNESCO, ISCED each level was matched primary education, lower secondary education, upper secondary education, post-secondary non-tertiary education, short-cycle tertiary education, bachelor, and master degree, respectively.

Table 9

Frequencies of Parents' Highest Level of Education

	Father		Mother	
	Frequency	Percent	Frequency	Percent
No School	4	.1	5	.1
ISCED 1 or 2	23	.6	8	.2
ISCED 2	383	9.5	246	6.0
ISCED 3	1401	34.6	1156	28.2

ISCED4	222	5.5	155	3.8
ISCED 5B	773	19.1	1095	26.7
ISCED 5A, first degree	466	11.5	609	14.8
Beyond ISCED 5A, first degree	776	19.2	828	20.2
Missing	546		492	
Total	4594	100.0	4594	100.0
Mean (SD)	5.44 (1.73)		5.76 (1.63)	

3.3 Analysis

In this study, to examine the significant influences of home literacy environmental factors on students' cognitive achievement and non-cognitive outcome of mathematics, multiple regression analyses were performed. The predictor variables were (1) early literacy education environment, (2) parents' attitude toward reading, (3) parents' involvement in students' literacy learning, and (4) the number of books and material sources at home. As for additional variables, (5) parents' highest level of education and (6) students' gender were used. The dependent variables are cognitive achievement and affective achievement, self-concept and attitude, toward mathematics.

In addition, by conducting interaction effect analysis which is the part of the regression analyses, the significant effects of combined two independent variables on a dependent variable were interpreted.

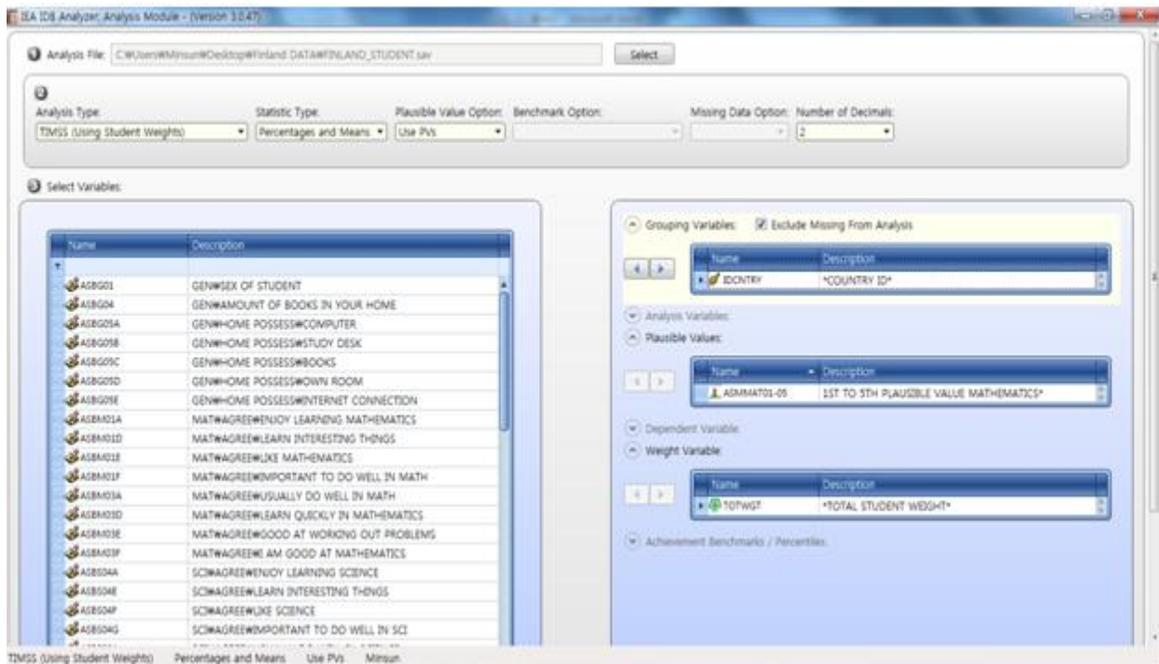
In this study, to explain the research questions, SPSS 20.0 and the IEA IDB Analyzer software (version 3.0, 2012) were used together. In order to use various types of TIMSS and PIRLS 2011 International database easily, the IEA IDB Analyzer software (version 3.0, 2012) developed by the IEA Data Processing and Research Center (IEA DPC) was appropriate. The IEA IDB analyzer has two modules, which are the merge

and analysis modules. The merge module makes a new dataset from a great number of data files appropriately for study and the analysis module enables computation of various statistical analyses.

The primary advantage to use the IEA IDB Analyzer is that SPSS syntax can be generated automatically, therefore, users carry out analysis easily without programming produces on this account. In addition, as for plausible values, the IEA IDB Analyzer performs the analyses of five times for each plausible value and leads to use of plausible values properly which are estimated achievement scores. Figure 1 shows the example of analysis.

Figure 1

IDB Analyzer Example of Analysis for Students' Cognitive Achievement in Mathematics



CHAPTER 4 RESULTS

This chapter consists of three sections with findings from multiple regression analyses. In the first section, I check statistical assumptions for the multiple regression analysis. In the second section, I present the results of multiple regression analyses for each dependent variable. In the third section, I check interaction effects to see if there is a distinguished effect made by two variables. I also include a summary of this chapter.

4.1 Assumptions in Multiple Regression Analysis

Before assessing whether literacy environmental factors at home affect students' cognitive and non-cognitive outcomes, outlier diagnostics and six assumptions in multiple regression analysis were performed. Since this study uses a large sample ($N = 4594$), outlier diagnostics were based on if studentized deleted residuals cases are outside the range ± 4 (i.e., large discrepancy). In this study, there were three outliers with case numbers 1778, 3510, and 3507. As for the first assumption which is the existence of linear relationship between independent variables (early literacy education environment, parental attitude toward reading, the number of books, material sources, parents' highest level of education, parents' involvement in students' literacy learning, and students' gender) and each dependent variable (mathematics academic achievement, self-concept in mathematics, and attitude toward mathematics), scatter plots were checked. Unstandardized residuals were plotted against all predictor variables and against unstandardized predicted values. In addition, Loess lines were fitted in the plots. When the linearity assumption is not violated, the Loess line generally follows the horizontal 0-line. For this study, it is found there is linearity between the independent variables and

each dependent variable. In this context, the assumption in terms of homoscedasticity of residuals was also checked with plotting the residuals against the predictor variables and the three predicted values. The residuals have constant variance across all values of the independent variable. Thus, this assumption was also satisfied.

Secondly, to figure out whether the model is correctly specified, the significance values of F change statistics in each model were checked. The values demonstrated that to predict mathematics academic achievement, the parental attitude toward reading was not a significant predictor. When adding the parental attitude toward reading variable to the model, R square did not increase significantly, $F_{\text{change}}(1, 3723) = 2.27, p = .132$. Therefore, in this model the parental attitude toward reading variable was not included to predict mathematics academic achievement. In the model of predicting self-concept in mathematics, it was believed that two variables which are material sources and parental attitude toward reading would not important predictors to use other predictors. When adding material sources variable and parental attitude toward reading variable to the original model, R square did not increase, $F_{\text{change}}(1, 3701) = .00, p = .987, F_{\text{change}}(1, 3700) = .20, p = .653$, respectively. Thus, the two variables, material sources and parental attitude toward reading, were not included in the model to predict students' self-concept in mathematics. For the last dependent variable, attitude toward mathematics, all variables except early literacy education environment and student's gender were found as irrelevant variables with not changing F value.

Next assumption to make certain is the reliability of independent variable. It is checked through Cronbach's alpha. To find this, the reliability values of each variable with related items were estimated simultaneously. Since each Cronbach's alpha value of

independent variables was greater than .70, the assumption about reliability met the requirements.

The last assumption in terms of normally distributed residuals was checked using histograms of residuals and normal probability plots. In the first model about mathematics academic achievement and the second model about self-concept in mathematics, the absolute values of skewness of all predictors were less than 1.965, $p = .05$ and the kurtosis values of all variables except material resources variable were almost 0 (kurtosis of material resources = 3.81). In the last model, for attitude toward mathematics, the absolute value of skewness was less than 1.965, $p = .05$ and the kurtosis value was close to 0. Therefore, the assumption of normality of residuals is also satisfied. Histograms and normality scatter plots of each model were shown Figure 2, Figure 3, and Figure 4.

Figure 2

Histogram and Normal P-P Plot of Students' Academic Achievement in Mathematics

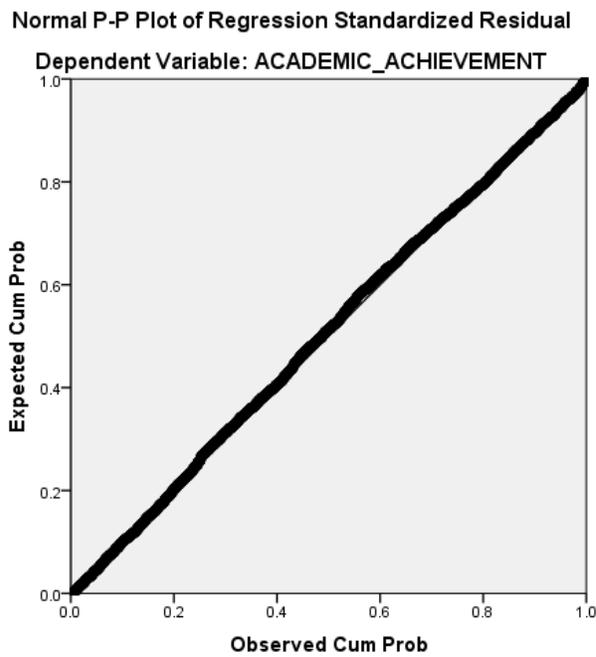
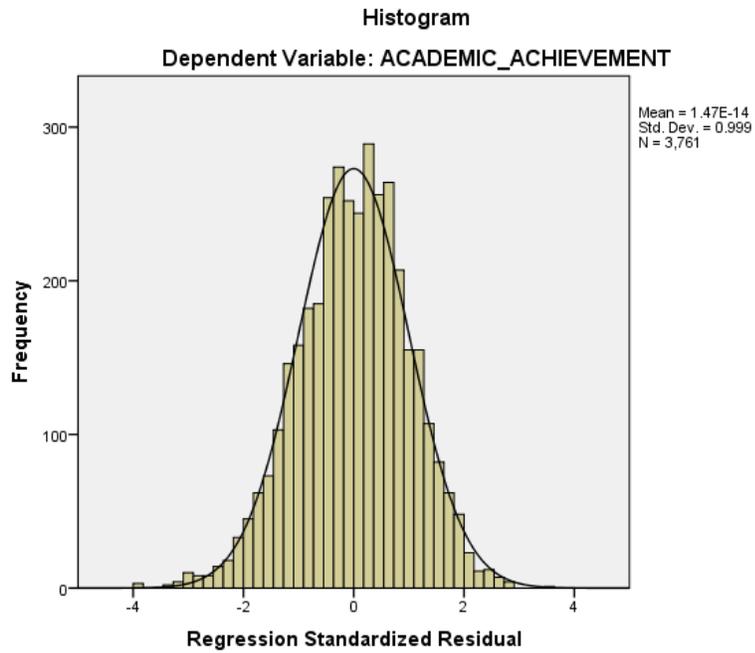


Figure 3

Histogram and Normal P-P Plot of Students' Self-concept in Mathematics

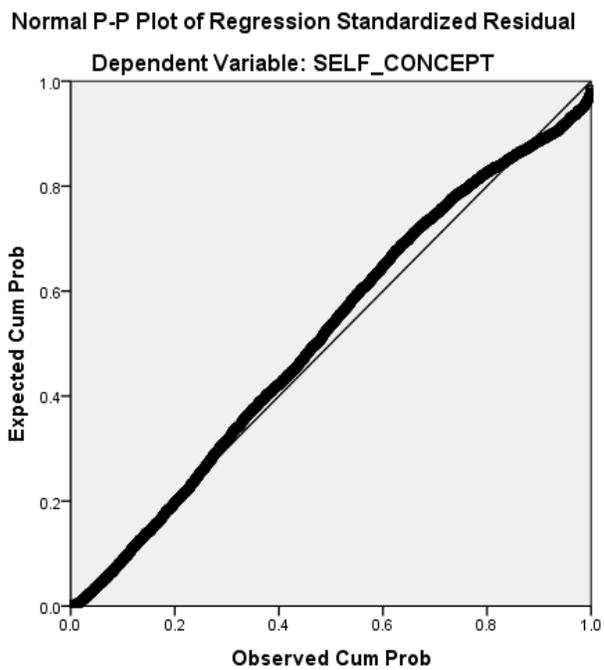
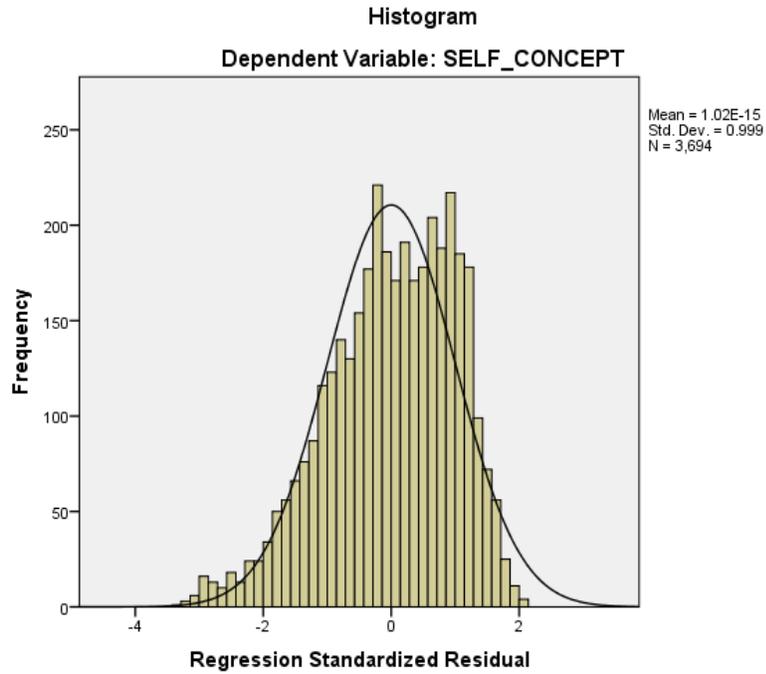
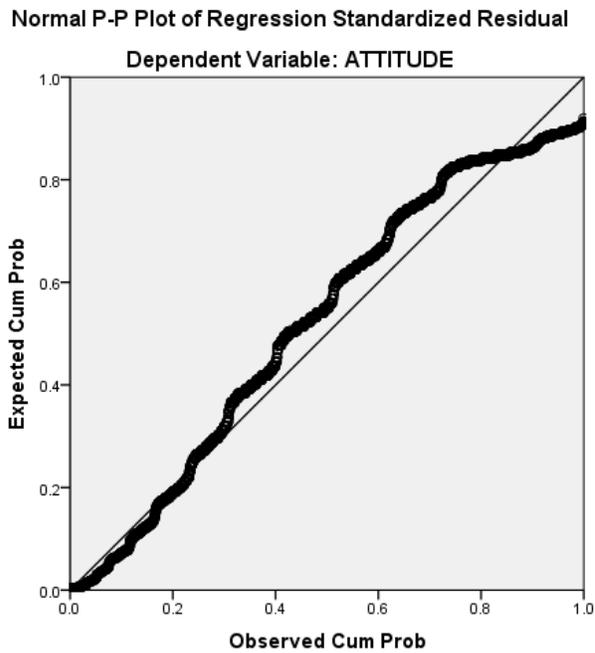
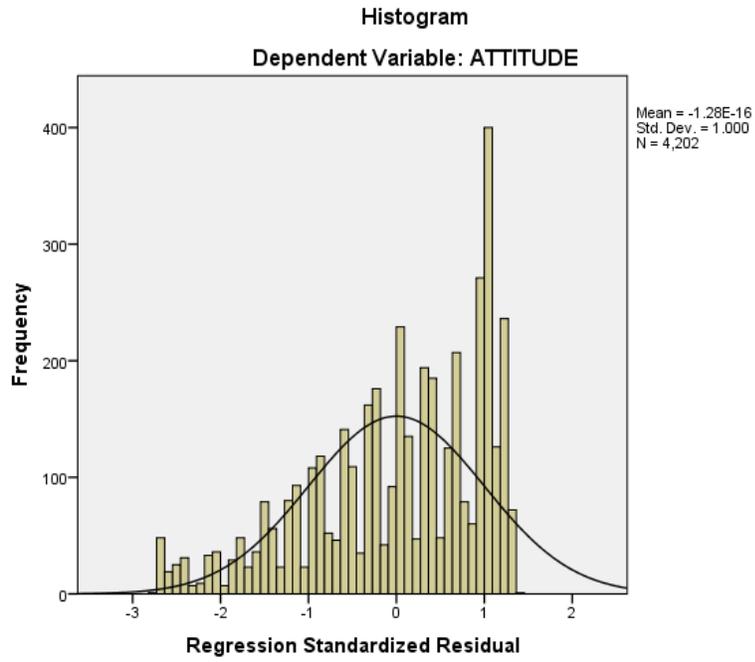


Figure 4

Histogram and Normal P-P Plot of Students' Attitude toward Mathematics



4.2 Multiple Regression Analysis

Analysis 1: Do all home variables considered in this study affect students' academic achievement in mathematics?

The first multiple regression analysis examines whether and how literacy education environmental factors at home predict students' academic achievement in mathematics. The parental attitude toward reading was removed from the model since it was not statistically significant. The rest independent variables together accounted for approximately 24% of variance in academic achievement in mathematics ($R_{\text{adj}}^2 = .240$), $F(6, 3754) = 198.81, p < .001$. The final model based on the stepwise method consisted of six predictors. All predictors affected mathematics academic achievement significantly based on the t statistics for regression coefficients: parents' involvement in students' literacy learning ($t = 23.65, p < .001$), parents' highest level of education ($t = 13.16, p < .001$), early literacy education environment ($t = 8.93, p < .001$), the number of books ($t = 7.64, p < .001$), material sources ($t = 4.88, p < .001$), and students' gender ($t = -6.25, p < .001$). In order of standardized coefficient which means relative contribution factor of predictors, parents' involvement in students' literacy learning, parents' highest level of education, early literacy education environment, the number of books, material sources, and students' gender had an effect on cognitive outcomes in mathematics. The linear equation to explain the relationship between predictors and students' academic achievement in mathematics is below:

Students' academic achievement in mathematics = $337.33 + 38.72(\text{parents' involvement}$

in literacy learning) + 8.55(parents' highest level of education) + 25.67(early literacy education environment) + 6.88(the number of books) + 7.10(material sources) – 11.00(students' gender)

Table 10

Descriptive Statistics Table of Students' Academic Achievement in Mathematics and Significant Home Variables

	Mean	Std. Deviation	N
Academic achievement	551.45	61.42	3761
Parents' involvement in literacy learning	2.06	.56	3761
Parents' highest level of education	5.65	1.44	3761
Early education environment	1.37	.32	3761
The number of books	3.36	1.03	3761
Material resources	4.68	.61	3761
Students' gender	.49	.50	3761

Table 11

ANOVA Table for the Regression of Students' Academic Achievement in Mathematics

	Sum of squares	df	Mean square	F	p
Regression	3420668.23	6	570111.37	198.81	.000
Residual	10765065.78	3754	2867.63		
Total	14185734.01	3760			

Table 12

Multiple Regression Analysis Table of the Relationship for Students' Academic Achievement in Mathematics

Variables	Unstandardized Coefficients		Standardized Coefficients(β)	t	p	VIF
	B	SE				
Constant	337.33	8.52		39.58	.000	
Parents' involvement	38.72	1.64	.35	23.65	.000	1.09

in students' learning						
Parents' highest level of education	8.55	.65	.20	13.16	.000	1.15
Early literacy education	25.67	2.87	.14	8.93	.000	1.12
The number of books	6.88	.90	.12	7.64	.000	1.13
Material sources	7.10	1.46	.07	4.88	.000	1.04
Students' gender	-11.00	1.76	-.09	-6.25	.000	1.02

Analysis 2: Do all home variables considered in this study influence students' self-concept in mathematics?

The analysis is also conducted through a multiple regression. In order to decide a significant model to explain the dependent variable, self-concept toward mathematics, the model after using stepwise method was including independent variables as in the following: early literacy education, parents' involvement in students' literacy learning, parents' highest level of education, the number of books, and students' gender except material sources and parental attitude toward reading. All predictors included in the model accounted for approximately 8.7% of the variance in students' self-concept in mathematics ($R_{adj}^2 = .087$), $F(4, 3689) = 88.69$, $p < .001$. Predictors affecting dependent variable were early literacy education ($t = 6.16$, $p < .001$), parents' involvement in students' literacy learning ($t = 8.41$, $p < .001$), parents' highest level of education ($t = 6.16$, $p < .001$) and student's gender ($t = -14.56$, $p < .001$). In terms of the number of

books variable, since this was not significant ($p = .34$), it could not explain whether this variable has an effect on students' self-concept in mathematics.

The estimated result of the linear equation to explain the relationship between predictors and students' self-concept is as in the following.

$$\begin{aligned} \text{Students' self-concept in mathematics} = & 1.16 + .18(\text{parents' involvement in literacy} \\ & \text{learning}) + .26 (\text{early literacy education}) + .05(\text{parents' highest level of education}) \\ & - .34(\text{students' gender}) \end{aligned}$$

Table 13

Descriptive Statistics Table of Students' Self-concept in Mathematics and Significant Home Variables

	Mean	Std. Deviation	N
Self-concept	2.02	.74	3694
Parents' involvement in literacy learning	2.06	.56	3694
Early education environment	1.37	.32	3694
Parents' highest level of education	5.64	1.44	3694
Students' gender	.49	.50	3694

Table 14

ANOVA Table for the Regression of Students' Self-concept in Mathematics

	Sum of squares	<i>df</i>	Mean square	<i>F</i>	<i>p</i>
Regression	177.59	4	44.40	88.69	.000
Residual	1846.64	3689	.50		
Total	2024.23	3693			

Table 15

Multiple Regression Analysis Table of the Relationship for Students' Self-concept in Mathematics

Variables	Unstandardized Coefficients		Standardized Coefficients(β)	<i>t</i>	<i>p</i>	VIF
	B	SE				
Constant	1.16	.08		14.47	.000	
Parents' involvement in literacy learning	.18	.02	.14	8.41	.000	1.08
Early literacy education	.26	.04	.11	6.87	.000	1.10
Parents' highest level of education	.05	.01	.10	6.16	.000	1.06
Students' gender	-.34	.02	-.23	-14.56	.000	1.01

Analysis 3: Do all home variables considered in this study have effects on students' attitude toward mathematics?

The last analysis is demonstrated using a multiple regression with two predictors since in the statistical significance test only early literacy education environment and students' gender were significant to predict students' attitude toward mathematics. The early literacy education environment and students' gender were explained approximately 1% of the variance in students' attitude toward mathematics ($R_{adj}^2 = .012$). The independent variables were significant predictors of dependent variable, $F(2, 4199) = 27.50, p < .001$. This analysis indicated that holding students' gender constant, as early literacy education environmental variable increase by 1 unit, the students' attitude toward mathematics is estimated to increase by about 1.36. The linear equation to explain the relationship between two predictors and attitude toward mathematics is as follows.

Attitude toward mathematics = 2.02 + .11(early literacy education) - .18(students' gender)

Table 16

Descriptive Statistics Table of Students' Attitude toward Mathematics and Significant Home Variables

	Mean	Std. Deviation	N
Attitude	2.08	.82	4202
Early literacy education	1.36	.33	4202
Students' gender	.49	.50	4202

Table 17

ANOVA Table for the Regression of Students' Attitude toward Mathematics

	Sum of squares	df	Mean square	F	p
Regression	36.13	2	18.06	27.50	.000
Residual	2758.01	4199	.66		
Total	2794.14	4201			

Table 18

Multiple Regression Analysis Table of the Relationship for Students' Attitude toward Mathematics

Variables	Unstandardized Coefficients		Standardized Coefficients(β)	t	p	VIF
	B	SE				
Constant	2.02	.05		37.17	.000	
Early literacy education	.11	.04	.04	2.87	.000	1.00
Students' gender	-.18	.03	-.11	-7.00	.000	1.00

4.3 Interaction Effects

Interaction effects in multiple regression can be thought of as moderation effects. A moderation effect exists when the moderating variable changes the relationship between the independent and dependent variables. The moderating variable divides into non-metric moderator for categorical variable and metric moderator for continuous variable. In this study, the two analyses of moderation effect were performed in the first analysis model.

An interaction effect can be found between two categorical variables, between two quantitative variables, or between a categorical variable and a quantitative variable. A new interaction term is created by two categorical variables which are coded dummy variables, to examine the interaction effect it generally use factorial ANOVA instead of regression. When using two quantitative variables to reduce the correlation between two independent variables and an interaction term, after conducting mean centering, a new interaction term between two quantitative predictors was created. However, in terms of an interaction term between a quantitative and a categorical variable, since it is not necessary to conduct mean centering (Aiken & West, 1991, p.131, "Centering revisited"), the new interaction term was created just a product term between variables without mean centering. In this study, two interaction terms are considered. One is between gender and parent involvement; and the other is between early literacy education and material sources.

4.3.1 Interaction between Students' Gender and Parents' Involvement

In the first analysis model, one of the predictors was parents' involvement in students' literacy learning and the dependent variable was students' academic

achievement in mathematics, and the result indicated that parents' involvement affects students' academic achievement in mathematics. As for the moderating variable, students' gender was selected. To assess gender differences in both the intercept and the slope for prediction of dependent variable, a regression was conducted to predict academic achievement in mathematics from gender (dummy coded 0=boy, 1=girl), parents' involvement, and an interaction term (parents' involvement \times gender). The overall regression was significant and explained approximately 13% of the variance in academic achievement in mathematics ($R_{adj}^2 = .129$), $F(3, 4265) = 211.65$, $p < .001$. Parents' involvement in students' learning had a significant effect on academic achievement in mathematics, with $t(4265) = 18.73$, $p < .001$, while the effect for gender was not statistically significant, with $t(4265) = .55$, $p = .582$. Parents' involvement uniquely predicted about 7% of the variance in academic achievement in mathematics ($sr^2 = .07$). The interaction between gender and parents' involvement was marginally significant ($t = -1.94$, $p = .052$). The interaction uniquely predicted approximately 0.1% of the variance in academic achievement in mathematics ($sr^2 = .001$). Table 19 shows the multiple regression analysis of the relationship for interaction term Involvement \times Gender.

Table 19

Moderation Effect Analysis Table of the Interaction Term Involvement \times Gender

Variables	Unstandardized Coefficients		Standardized Coefficients(β)	<i>t</i>	<i>p</i>
	B	SE			
Constant	464.17	4.81		96.58	.000
Parents' involvement	42.84	2.29	.38	18.73	.000
Students' gender	3.74	6.79	.03	.55	.582
Involvement \times Gender	-6.23	3.20	-.11	-1.94	.052

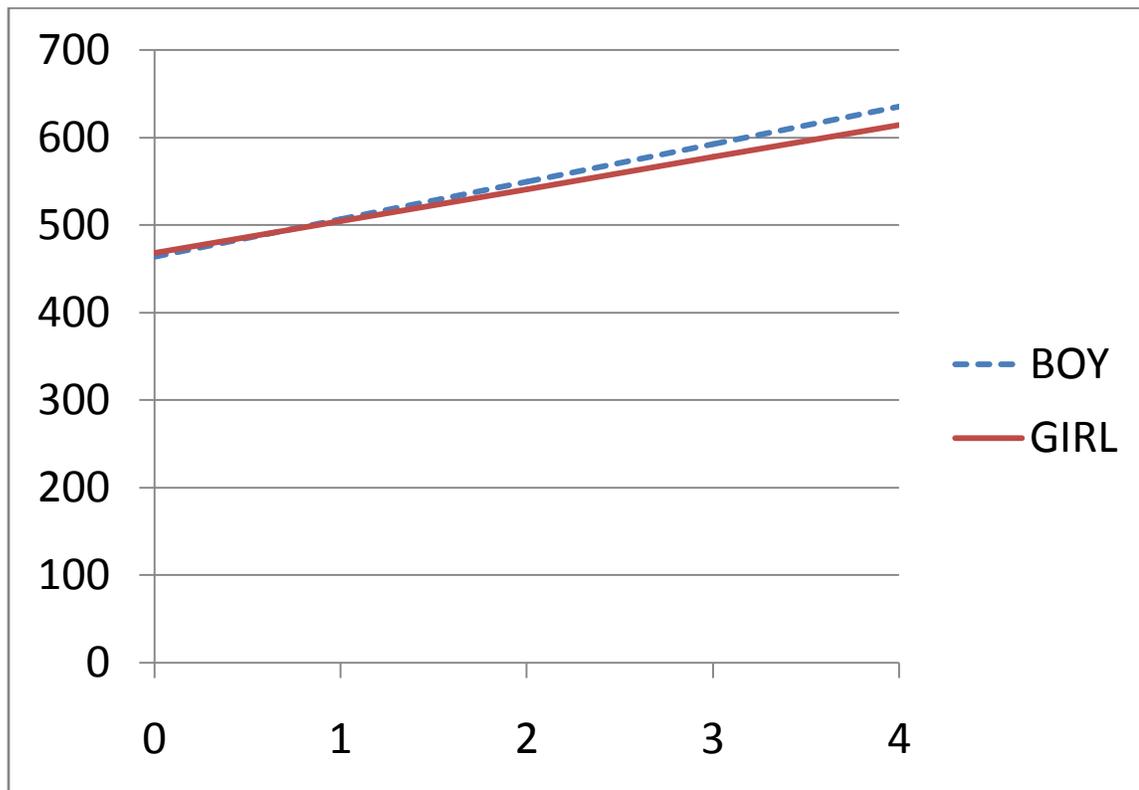
The regression equations and the graph to predict academic achievement in mathematics from parents' involvement were as in the following.

Boy subgroup: $464.17 + 42.84 \times \text{Parents' Involvement in literacy learning}$

Girl subgroup: $467.91 + 36.61 \times \text{Parents' Involvement in literacy learning}$

Figure 5

Graph Regression Lines for Subgroups to Predict Academic Achievement in Mathematics from Parents' Involvement



Gender did not differ significantly in predicted academic achievement in mathematics at parents' involvement is equal to 0; however, as parents' involvement increase 1 unit, the academic achievement in mathematics is estimated to increase for

boys (42.84 scores) and for girls (36.61 scores). The predicted academic scores increase per unit of parents' involvement 6.23 higher for boys than for girls. At higher units of parents' involvement, this difference in slopes resulted in a large gender difference in predicted academic scores.

4.3.2 Interaction between Early Literacy Education and Material Sources

To assess whether early literacy education environment interact with material resources to predict student's academic achievement in mathematics, a regression was performed from early literacy education, material resources, and an interaction term which was early literacy education \times material resources. Early literacy education environment ranged from 0 to 2, and material resources ranged from 1 to 5. The overall regression was significant and explained approximately 3% of the variance in academic achievement in mathematics ($R_{adj}^2 = .030$), $F(3, 4255) = 44.74$, $p < .001$. There was a significant for early literacy education ($t(4255) = 7.39$, $p < .001$, $sr^2 = .01$) and for material resources ($t(4255) = 8.32$, $p < .001$, $sr^2 = .02$). In addition, there was a significant effect for interaction term (early literacy education \times material resources), with $t(4255) = 2.00$, $p < .05$. Table 20 shows the multiple regression analysis of the relationship for interaction term early literacy education \times material resources.

Table 20

Moderation Effect Analysis Table of the Interaction Term Early Literacy Education \times Material Resources

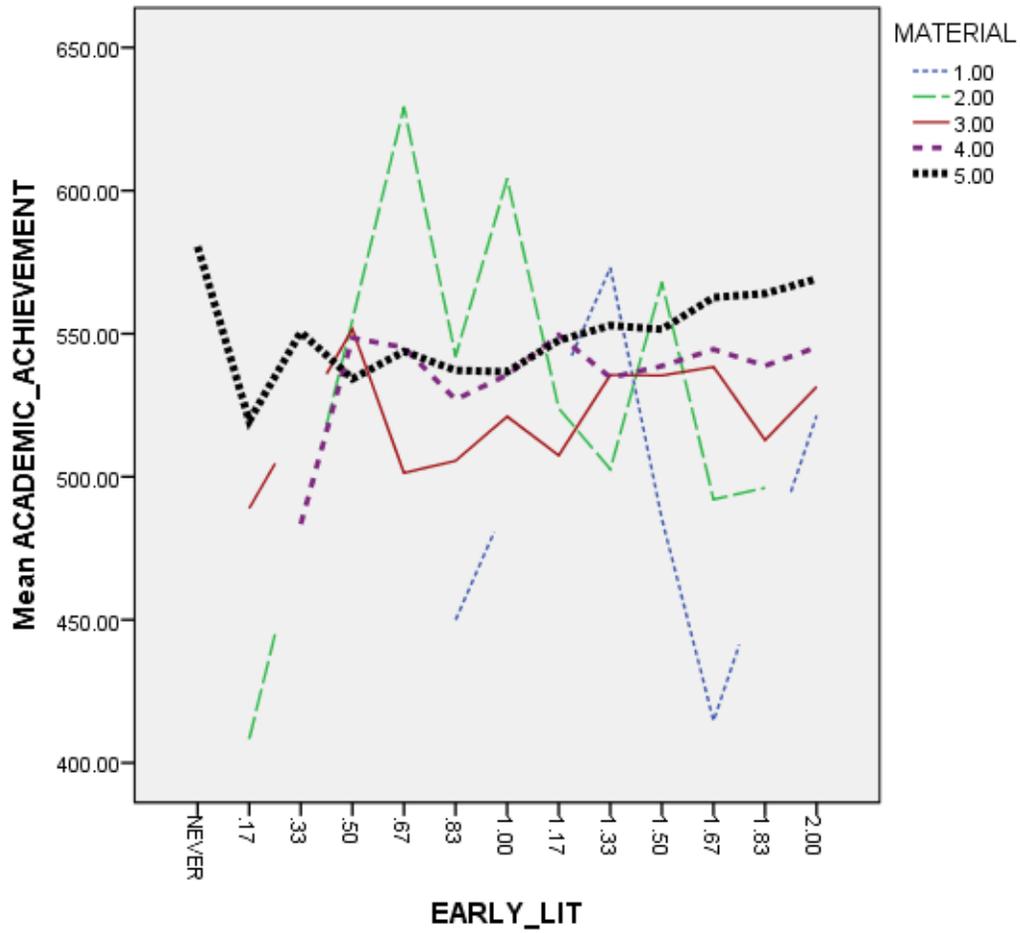
Variables	Unstandardized Coefficients		Standardized Coefficients(β)	<i>t</i>	<i>p</i>
	B	SE			

Constant	459.47	7.90		58.14	.000
Early literacy education	21.55	2.92	.11	7.39	.000
Material resources	12.61	1.52	.13	8.32	.000
Early × Material	8.80	4.41	.03	2.00	.046

The material resources subunits, which are equal to 1 to 4, were not significantly predicted of students' achievement scores, with $F(1, 3) = .07, p = .812$, $F(1, 33) = .42, p = .523$, $F(1, 237) = 3.70, p = .056$, $F(1, 841) = .83, p = .362$, respectively. However, the last subunit that coded material resource is equal to 5 was significantly predicted of students' achievement scores, with $F(1, 3135) = 58.12, p < .001$. The significant interaction between early literacy education and material resources demonstrated that the association between early literacy education and students' academic achievement in mathematics is strong at high units of materials. Figure 6 shows the regression prediction lines for material resources units to see the nature of the early literacy education-by-material resources interaction.

Figure 6

Graph Regression Lines for Subunits to Predict Academic Achievement in Mathematics from Early Literacy Education Environmental Factor



4.4 Summary

This study examined the influences of literacy education environmental factors at home on students' academic achievement, self-concept, and attitude toward mathematics. According to the results, seven environmental factors considered in this study had significant effects on each dependent variable. For mathematics academic achievement,

there were six significant predictors: parents' involvement in students' literacy learning, parents' highest level of education, early literacy education environment, the number of books, material sources and students' gender differences explained each influences. Those variables accounted for about 24% of variance in mathematics academic achievement. Since parental attitude toward reading variable was not statistically significant, this variable was removed for explaining academic achievement in mathematics. For self-concept in mathematics, there were four significant predictors: parents' involvement in literacy learning, early literacy education, parents' highest of education, and students' gender differences. The four significant predictors predicted approximately 8.7% of the variance in self-concept in mathematics. The three variables that were excluded among seven predictors suggested in this study were not statistically significant as explaining self-concept dependent variable, which were parental attitude toward reading, material sources, and the number of books. For the last dependent variable, attitude toward mathematics, there were only two significant predictors: early literacy education environment and students' gender difference is explained. Those two variables accounted for approximately 1% of the variance in attitude toward mathematics, and the rest of the predictors were not significant in this dependent variable.

From the two moderation effect analyses, the interaction terms between students' gender and parents' involvement in students' literacy learning and between early literacy education and material sources were significant on academic achievement in mathematics, with explaining about 0.1% and 3% of the variance, respectively. The first moderation effect analysis indicated that the more parents are involved on students' literacy learning, the less effect on girls' academic achievement in mathematics. In the second moderation

effect analysis, the relationship between early literacy education and students' academic achievement in mathematics is strong at high units of materials.

CHAPTER 5 DISCUSSION

This chapter consists of three sections. The first section discusses the major findings of this study. The second section discusses contributions, limitations, and future directions. The last section summarizes and concludes this study.

5.1 Major Findings

5.1.1 Academic Achievement in Mathematics

The first research question was whether literacy education environmental factors at home affect students' academic achievement in mathematics. There were significant influences between each environmental factor suggested in this study, except parental attitude toward reading variable and students' academic scores in mathematics. In terms of parents' involvement in students' learning, most of the studies defined parents' involvement as overall activities within not only the home but also at school and indicated that parents' involvement has strong effect on students' academic achievement (Barnard, 2004; Keith et al., 1998; Lee et al., 2006). On the contrary, in this study, the concept of parents' involvement in students' learning was used in a limited way for students' literacy learning, and this variable had the most immediate and significant influence to students' cognitive achievement in math. This result shows that even only parental help or participation on children's literacy learning at home makes significant differences on not only literacy achievement but also mathematics academic achievement. In addition, from the result, parents' involvement makes gender differences of academic scores. In other words, the effect of parents' involvement in literacy learning for boys' academic achievement in math is greater than for girls. Even though parents' highest

level of education is not directly related with literacy education factor at home, it is clear that there are differences of parents' language and literacy level, depending on level of parents' education. In this study, it is indicated that such differences would affect students' learning, including both literacy and mathematics academic achievement. In this study, early education environment factor was also significant to predict math academic achievement, which can be explained with the Matthew effect (Stanovich, 1986). Since students need literacy for solving mathematics problems, the more opportunities that students have to have learning related with literacy, the better achievement scores (even in mathematics) they receive. The influences of the number of books and material sources on academic achievement were consistent with other studies (Neuman, 1996; Park, 2008). This means that the structural and physical factors for literacy education play an important role on academic achievement. In this study, the books or material sources are limited only at home; however, this result would extend other places where children meet such physical materials comfortably such as in their homes.

5.1.2 Self-concept in Mathematics

The second research question was about the influence of literacy education environmental factors at home on students' self-concept in mathematics. This study concluded that some predictors (parents' involvement in literacy learning, early literacy education, parents' highest level of education, and students' gender) explain the students' self-concept in mathematics.

In general, self-concept is considered as the child's view of himself/herself and like assessment of his/her ability or his/her status. Although the evaluation area and important point of views are different from mathematics and English, children need literacy skills such as reading and writing to learn mathematics. Therefore, if a student lacks literacy ability, self-concept on not only reading but also mathematics would be low. In other words, if a student has high literacy ability, then his self-concept would also be high. According to the Matthew effect (Stanovich, 1986) literacy ability is related to early literacy education environment, and the result of this study is also consistent with the effect.

The parents' involvement in literacy learning also shows significant influences on students' self-concept in mathematics. According to Barnard (2004), parents' involvement in students' learning indicates the positive relationship with academic performance. From this study, parent involvement also explains not only academic achievement, but students' self-concept.

In addition, this study indicated that girls' self-concept in mathematics is lower than boys'. This is consistent with general hypothesis about different level of the self-concept in mathematics from gender difference.

5.1.3 Attitude toward Mathematics

The third research question was whether home variables related with literacy education affect students' attitude toward mathematics. In this study, the result showed only early literacy education and students' gender had a significant effect on students' attitude toward mathematics.

Earlier studies only focused on the relationship between literacy education at home and attitude toward reading (Csikszentmihalyi, 1991) and claimed the relationship is significant. From this study, literacy education influence was extended to explain about attitude toward mathematics, including reading attitude. Therefore, literacy education has relevance to attitude toward different academic subjects.

According to the result from this study, there is a positive relationship between students' attitude and early literacy education. This shows the importance of early literacy education again and asserts the need to develop early literacy education simultaneously.

In addition, this study concludes that students' gender is also a significant influence on students' attitude. According to the result of gender differences, girls' attitude toward mathematics is lower than boys'.

Therefore, this would explain the major difference on attitude toward mathematics comes from literacy ability and gender difference, and the literacy ability could be developed by early literacy education environmental factor.

5.2 Limitations and Future Research

5.2.1 Limitations

Although the data used in this study satisfied an ideal condition such as sample size, well-balanced gender ratio, and various kinds of sample group, there were still limitations in terms of data. First, there were a number of missing and unusable data that cannot be explained. In addition, since these data were collected only from Finland, the findings cannot be generalized to explain the overall situation; it can only be used for

comparison. Another problem was the method to collect data. Because these data were collected through self-reported methods from fourth-grade students and their parents, it is hard to judge whether the participants responded honestly or accurately. Last, the problem of data was the number of items used to construct variables. Since each variable consists of only four or five items, it was not sufficient to express the characteristic of the construct.

5.2.2 Future research

This study examined the effects of literacy education environmental factor on cognitive and non-cognitive outcomes of mathematics. The findings from this study suggest for future study to explore the relationship with other environmental factors. For example, there are SES and environmental factors from school. Since the SES factor is an important standard to evaluate home environmental characteristic, it would be meaningful to use this factor. Students spend most of their time in school, therefore school environmental factors such as structured factor and school curriculum should be considered. In addition, since only two variables were used as the non-cognitive variable, in the future research, using various kinds of non-cognitive variables, the effectiveness of literacy education could be better supported. As for data, to figure out the long-term effect from literacy education environment, a longitudinal study with the same participants is needed. Lastly, the parental attitude toward reading should be considered again with higher reliability. According to Bandura's (1986) social learning theory, since the relationship between this variable and students' behavior could be explained as strong, future research should explore this variable.

5.3 Summary and Contributions

5.3.1 Summary

This study demonstrates the importance of literacy education related to academic outcomes and describes literacy education environmental factors as a way to develop literacy education. In other words, by showing the relationship between literacy education environmental factors and cognitive and non-cognitive mathematics outcomes, the supporting characteristics of environmental factors were explained.

A total of seven predictors were explained with academic achievement, self-concept, and attitude toward mathematics. Although each variable's influence on each dependent variable differed, literacy education environmental factors had effects on explaining and developing of all dependent variables. Especially, the early literacy education variable and students' gender were used as significant predictors on all dependent variables.

5.3.2 Contributions

First, this study extended the knowledge of literacy education influences on students' performance. In this study, the effect of literacy education was explained with students' mathematics outcomes, whereas earlier studies only focused on reading or writing achievement. Therefore, with proving the significant relationship between literacy education and even students' outcomes in mathematics, the importance of literacy education was clarified and its extended influences was demonstrated.

Second, in this study, students' performance was considered through different types of outcomes, specifically cognitive and non-cognitive outcomes. Whereas earlier studies used either of them as a dependent variable or different predictors to explain each cognitive and non-cognitive variable, this study explained the research questions with the same predictors, and the predictors were distinguished by whether there is direct relevance with cognitive or non-cognitive outcomes. The major finding from this study is that the significant effect of the early literacy education variable was found on all dependent variables, which are academic achievement, self-concept, and attitude in mathematics. This means that the early literacy education has an effect on students' later academic achievement and affective area, not only in reading, but also mathematics.

Third, this study explained the importance of environmental factors comprising literacy education. Literacy education was generally considered teaching ability of reading and writing. In the current study, however, literacy education is composed of environmental factors, such as early literacy education environment, parents' involvement in literacy learning, and the number of books a student reads. In other words, with indicating the significance of environmental factors, literacy education was redefined with direct and interact effects from environmental factors.

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