A CROSS-CULTURAL COMPARISON OF FACTORS AFFECTING MATHEMATICAL LITERACY OF STUDENTS IN PROGRAMME FOR INTERNATIONAL STUDENT ASSESSMENT (PISA)

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ABSTRACT

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The purpose of the present study is to investigate the factors affecting mathematical literacy of 15-year-old students in Programme for International Student Assessment (PISA) across different cultural settings.

The present study was conducted across three countries. These countries are Brazil, Japan and Norway. The countries were selected on the basis of their rankings in PISA 2000 study. Japan represented a high performing country with an average score of 557, Norway represented an average performing country with an average score of 499, and Brazil represented a low performing country with an average score of 334.

The study explored how mathematical literacy is stimulated by predictors related to the students, the families and the school. A separate factor analysis was carried out for each questionnaire such as student questionnaire and cross curricular competencies questionnaire within the data of each country. Since the results of factor analyses of three countries were parallel, the observed variables representing the latent variables were selected from the student questionnaire and cross curricular competencies questionnaire administered in PISA 2000 in order to be used in the structural equation modeling. The included factors affecting mathematical literacy in PISA 2000 are attitudes towards reading, student-teacher relations, climate, communication with parents, usage of technology and facilities, attitudes towards mathematics and reading literacy.

The proposed model was tested using structural equation modeling across three different cultures with different performance levels in PISA 2000. The findings of the study show that the latent independent variable having the strongest effect on mathematical literacy is the usage of technology and facilities in Brazil, communication with parents in Japan and attitudes towards reading in Norway. Moreover, the results were as follows: (1) Reading literacy significantly and positively influences mathematical literacy in all three countries. (2) There is a reciprocal relationship between the attitudes towards mathematics and mathematical literacy. In Brazil, the influence of attitudes towards mathematics on mathematical literacy is higher. However, the influence of mathematical literacy on attitudes towards mathematics is higher in Norway. (3) The attitudes towards reading have a negative direct effect and a positive indirect effect on mathematical literacy. (4) The student-teacher relations have a positive effect on mathematical literacy in Japan and Norway. But, in Brazil, this effect is negative. (5) The student-related factors affecting school climate are significantly and positively related to mathematical literacy in Brazil. On the other hand, the effect of climate on mathematical literacy is negative in Japan and non-significant in Norway. (6) Communication with parents significantly and positively influences the mathematical literacy in all three countries. (7) The usage of technology and facilities significantly and positively affects mathematical literacy in Brazil. However, this effect is negative in Japan and non-significant in Norway.

Key Words: Programme for International Student Assessment (PISA), Mathematical Literacy, Structural Equation Modeling, Reading Literacy, Attitudes towards Mathematics, Reciprocal Relationship, Attitudes towards Reading, Student-Teacher Relations, Climate, Communication with Parents, Usage of Technology and Facilities.

ÖZ

ULUSLARARASI ÖĞRENCİ BAŞARI BELİRLEME PROGRAMINA GÖRE (PISA) MATEMATİK OKUR YAZARLIĞINI BELİRLEYEN FAKTÖRLERİN KÜLTÜRLER ARASI KARŞILAŞTIRILMASI

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Bu çalışmanın amacı, farklı kültürlerde 15 yaşındaki öğrencilerin Uluslararası Öğrenci Başarı Belirleme Programındaki (PISA) matematik okur yazarlıklarını etkileyen faktörlerin incelenmesidir.

Bu çalışma, Uluslararası Öğrenci Başarı Belirleme Programına katılan üç ülke üzerinde gerçekleştirilmiştir. Bu ülkeler, Brezilya, Japonya ve Norveç'tir. Bu ülkeler, PISA 2000 projesindeki sıralamaları baz alınarak seçilmiştir. Ortaması 557 olan Japonya üst sıralarda yer alan bir ülkeyi temsil etmektedir.Ortalaması 499 olan Norveç orta sıralarda yer alan bir ülkeyi ve ortalaması 334 olan Brezilya da alt sıralarda yer alan bir ülkeyi temsil etmektedir.

Bu çalışmada, matematik okur yazarlığını etkileyen öğrenci, aile ve okul ile ilgili faktörler araştırılmıştır. Her bir ülke verileri baz alınarak, öğrenci anketi ve öğrencilerin tutumlarının ölçüldüğü anket olmak üzere her anket için ayrı faktör analizi yapılmıştır. Üç ülkenin faktör analizi sonuçları birbirine paralel çıkmıştır. Faktör analizi sonuçlarına göre, örtük değişkenleri oluşturan gözlenen değişkenler seçilmiştir. Bu gözlenebilen ve örtük değişkenler, yapısal denklem modellemesi analizlerinde kullanılmıştır. Çalışmada matematik okur yazarlığını etkileyen faktörler olarak incelenen örtük değişkenler; anadile yönelik tutumlar, öğretmen-öğrenci ilişkileri, sınıf ortamı, aile ile olan iletişim, teknoloji ve kaynak kullanımı, matematiğe yönelik tutumlar ve anadil okur yazarlığıdır.

Uluslararası Öğrenci Başarı Belirleme Programında farklı performans seviyeleri sergileyen üç farklı kültür için ayrı ayrı yapısal denklem modellemesi analizi yürütülmüştür. Çalışmanın bulgularına göre, teknoloji ve kaynak kullanımı Brezilya'da matematik okur yazarlığında en güçlü etkisi olan bağımsız örtük değişkendir. Aynı şekilde, matematik okur yazarlığında en güçlü etkisi olan bağımsız örtük değişken, Japonya'da aile ile olan iletişim bulunurken, Norveç'te anadile yönelik tutumlar bulunmuştur. Ayrıca çalışmada elde edilen sonuçlar şöyle sıralanabilir: (1) Üç ülkede de anadil okur yazarlığı matematik okur yazarlığını pozitif ve istatiksel olarak anlamlı bir şekilde etkilemektedir. (2) Matematik okur yazarlığı ile matematiğe yönelik tutumlar arasında karşılıklı bir ilişki bulunmuştur. Brezilya'da matematiğe yönelik tutumlar matematik okur yazarlığını daha fazla etkilemekteyken, Norveç'te matematik okur yazarlığı matematiğe yönelik tutumları daha fazla etkilemektedir. (3) Anadile yönelik tutumların matematik okur yazarlığına direkt etkisi negatifken, indirekt etkisi pozitiftir. (4) Japonya ve Norveç'te öğretmen-öğrenci ilişkileri matematik okur yazarlığı arasında pozitif bir ilişki varken, Brezilya'da bu ilişki negatiftir. (5) Brezilya'da öğrencilere ilişkin faktörlerin etkilediği sınıf ortamı matematik okur yazarlığını pozitif olarak etkilemektedir. Ancak Japonya'da sınıf ortamı ile matematik okur yazarlığı arasındaki ilişki negatifken, Norveç'te bu ilişki istatistiksel olarak anlamlı bulunmamıştır. (6) Üç ülkede de aile ile olan iletişimin matematik okur yazarlığını pozitif ve istatiksel olarak anlamlı etkilediği bulunmuştur. (7) Teknoloji ve kaynak kullanımının matematik okur yazarlığı ile olan ilişkisi Brezilya'da pozitif, Japonya'da ise negatif

olarak bulunmuştur. Fakat, Norveç'te teknoloji ve kaynak kullanımının matematik okur yazarlığını istatiksel olarak anlamlı bir şekilde etkilemediği bulunmuştur.

Anahtar Kelimeler: Uluslararası Öğrenci Başarı Belirleme Programı (PISA), Matematik Okur Yazarlığı, Yapısal Denklem Modellemesi, Anadil Okur Yazarlığı, Matematiğe Yönelik Tutumlar, Karşılıklı İlişki, Anadile Yönelik Tutumlar, Öğretmen-Öğrenci İlişkileri, Sınıf Ortamı, Aile ile olan İletişim, Teknoloji ve Kaynak Kullanımı

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LIST OF ABBREVIATIONS

Favhobby = Favourite Hobby

Feelhapp = Feel Happy

Enjoylib = Enjoy Library

Talkbook = Talking about Books

Rehaveto = Only if I Have To

Fewminut = Few Minutes Only

Wastetim = Waste of Time

Listenme = Listen to Me

Interest = Interested in Students

Extrhelp = Give Extra Help

Treafair = Treat Me Fairly

Wellstud = Well with Students

Noise = Noise and Disorder

Nothing = Doing Nothing

Notstart = Students Don’t Start

Nolisten = Students Don’t Listen

Longtime = Teachers Wait Long Time

Noworkwe = Students Cannot Work Well

Justtalk = Just Talking

Discussb = Discuss books

Discussp = Discuss School Problems

Mainmeal = Eat Main Meal

Usecompu = How Often Use Computers

Calculat = How Often Use Calculators

Schoolib = How Often Use School Library

Donewell = Done Well

Mgoodmar = Good Marks Math

Mathbest = Math Best

Mathfun = Math Fun

Mathimpo = Math Important

Mabsorbe = Math Absorbed

Pv1math = 1^{st} Plausible Value of Math Scores

Pv2math = 2^{nd} Plausible Value of Math Scores

Pv3math = 3^{rd} Plausible Value of Math Scores

Pv4math = 4^{th} Plausible Value of Math Scores

Pv5math = 5^{th} Plausible Value of Math Scores

Pv1read = 1^{st} Plausible Value of Reading Scores

Pv2read = 2^{nd} Plausible Value of Reading Scores

Pv3read = 3^{rd} Plausible Value of Reading Scores

Pv4read = 4^{th} Plausible Value of Reading Scores

Pv5read = 5^{th} Plausible Value of Reading Scores

ATTREAD = Attitude towards Reading

RELATION = Student-Teacher Relations

CLIMATE = Climate

COM = Communication with Parents

USAGE = Usage of Technology and Facilities

ATTMATH = Attitude towards Mathematics

READLIT = Reading Literacy

MATHLIT = Mathematical Literacy

CHAPTER 1

INTRODUCTION

This study tries to model factors affecting mathematical literacy through the use of data from Programme for International Student Assessment (PISA) conducted by Organisation for Economic Co-operation and Development (OECD) across three different cultures.

1.1 Literacy and PISA Literacy Concept

An essential objective of schooling is the development of literate people. This corresponds that all the adults in a society are able to read and write. Literacy is important for personal fulfillment, full adult participation in social, cultural and political life, personal empowerment and success in securing and maintaining employment.

The responsibility of the schools is to train mathematically literate, scientifically literate and technologically literate people in order to create a future society. Therefore, for much of the century, the curriculums of mathematics and science were prepared in accordance with the foundations for the professional training of mathematicians, scientists and engineers.

But, the objectives of personal fulfillment, employment and full participation in society require adults who are not only able to read and write, but also mathematically, scientifically and technologically literate with the increasing role of mathematics, science and technology in modern life.

PISA literacy concept focuses on the knowledge, understanding and skills required for effective functioning in everyday life. Mastery of a body of basic knowledge and skills is required in literacy for effective participation in a modern society.

Reading literacy depends on the ability to decode text, to interpret meanings of words and grammatical structures and to construct meaning at least at a superficial level. On the other hand, much more than this is required in reading literacy for effective participation in a modern society. In this context, reading literacy depends on the ability to read between the lines and to reflect on the purposes and intended audiences of texts, to recognize devices used by writers to convey messages and influence readers and to interpret meanings from the structures and features of texts. As a result, reading literacy depends on the ability to understand and interpret a wide variety of text types, and to make sense of texts by relating them to the contexts in which they appear (OECD Publications, 2001).

Similarly, mathematics literacy depends on the familiarity of a body of mathematical knowledge and skills including basic number facts and operations, working with money, fundamental ideas about space and shape including working with measures, and notions of uncertainty, growth and change. On the other hand, much more than this is required for mathematical literacy for effective functioning in a modern society. In this context, mathematical literacy depends on the ability to think and work mathematically, including modeling and problem solving. The required competencies include knowing the extent and limits of mathematical concepts, following and evaluating mathematical arguments, posing mathematical problems, choosing ways of representing mathematical situations, and expressing oneself on matters with a mathematical content. Consequently, mathematical literacy depends on the ability to apply this knowledge, this understanding and these skills in a wide variety of personal, social and work contexts (OECD Publications, 2001).

PISA defines reading literacy as (OECD Publications, 2001):

> Reading literacy is the ability to understand, use and reflect on written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society (p.21).

PISA also defines mathematical literacy as (OECD Publications, 2001):

> Mathematical literacy is the capacity to identify, to understand, and to engage in mathematics and make well-founded judgments about the role that mathematics plays, as needed for an individual's current and future private life, occupational life, social life with peers and relatives, and life as a constructive, concerned and reflective citizen (p.22).

Literacy is a lifelong process taking place not just at school or through formal learning, but also through interactions with peers, colleagues and wider communities. At the beginning, the students need only a foundation of knowledge in areas such as reading and mathematics. However, they need to understand some basic processes and principles and have the flexibility to use them in different situations in order to go on learning in these domains and to apply their learning to the real world. Therefore, the ability to undertake a number of fundamental processes in a range of situations with a broad understanding of key concepts is emphasized in PISA domains of literacy.

1.2 Mathematical Literacy in PISA

The focus of mathematical literacy is on students' abilities to analyze reason and communicate ideas effectively by posing, formulating and solving mathematical problems. Mathematical literacy skills include thinking, argumentation, modeling, problem posing and solving, representation, symbolic, technical, communication skills and skills in using mathematical tools and aids.

The ability to apply mathematical knowledge, skills and understandings in authentic contexts is included in mathematical literacy. The context is considered authentic because it forms the actual experience and practices of part of participants in a real-world setting. Mathematical literacy is to do and use mathematics in a variety of situations. Personal life, school life, work and sports, the local community and society as encountered in daily life and scientific contexts are included in these situations.

Consequently, the term literacy emphasizes that mathematical knowledge and skills as defined within the traditional school mathematics curriculum do not constitute the primary focus of PISA. Instead, the emphasis is put on mathematical knowledge to functional use in a variety of different contexts and ways that call for reflection and insight.

Since this study used the data from Programme for International Student Assessment (PISA) conducted by Organisation for Economic Co-operation and Development (OECD), brief descriptions of the OECD and PISA were given.

1.3 Organisation for Economic Co-operation and Development

The Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy.
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development.
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996), Korea (12th December 1996) and the Slovak Republic (14th December 2000).

1.4 Programme for International Student Assessment (PISA)

The OECD's Programme for International Student Assessment (PISA) is a collaborative effort among the member countries of the OECD. The purpose of the study is to measure how well the 15-year-old students are prepared to meet the challenges of today's knowledge and societies.

The previous studies assessed the extent to which the students have mastered a specific curriculum. But PISA focuses additionally on the ability of students to use their knowledge and skills to meet real-life challenges. The assessment concerns not only with whether they have learned, but also with what the students can do with what they learn at school.

PISA is an international effort in order to assess student performance. In addition, data is collected on the student, family and institutional factors that can be useful to explain the differences in performance. The steps were acquired in order to ensure the validity and reliability of the assessment. Therefore, the results of PISA have a high degree of validity and reliability.

PISA 2000 surveyed reading literacy, mathematical literacy and scientific literacy. A primary focus was given to reading literacy in PISA 2000. Moreover, PISA 2000 obtained information about the measures of attitudes of learning and information on how students manage their own learning.

The content that students need to acquire, the processes that need to be performed and the contexts in which knowledge and skills are applied are the bases of the assessment.

1.5 The Present Study

Since the assessment of PISA project was in the year 2000, not many researchers have conducted any research study about PISA. Fredriksson (2001) conducted an informative study about the PISA project. In addition, the PISA data were used in order to compare the education in Britain with the educations in other countries. Taylor and Francis Group (2002) published an article explaining the properties of PISA and the report, Knowledge and Skills for Life-First Results from PISA 2000. The article also examines the first cycle of PISA project by using the report. McQuenn and Mendelovits (2003) discuss the steps taken to attain cultural relevance and appropriateness in the reading literacy construct and in the stimulus materials and items which operationalize it. Grisay (2003) describes the procedures implemented by the PISA International Center for the development of national versions of the assessment instruments in all instruction languages used in the participating countries.

The mathematical performance of the students is an essential factor in the field of mathematics education, because the mathematics performance symbolizes the success in the mathematics education. The performance of the students in mathematics is the main focus in the research. Many researchers have studied the factors affecting the performance of the students in mathematics for a long time. The aim of the studies in this field is to investigate these factors in order to increase the students' performances in mathematics. On the basis of the findings of these studies, the educators can make the appropriate modifications in mathematics education.

A number of studies have investigated the relationship between the attitudes towards reading and achievement in reading (Greenberg, Gerver, Chall & Davidson, 1965; Askov & Fishbach, 1973; Rowell, 1972-1973; Deck & Barnette, 1976; Nielson, 1978; Roettger, Szymezuk & Millard, 1979; Schofield, 1980; Quinn & Jadav, 1987; Tocci & Engelhard, 1991; Papanastasiou, 2002).

Most of the researchers found that the relationship between attitudes towards reading and achievement in reading is statistically significant. Moreover, the correlation between these variables is often positive (Greenberg, Gerver, Chall & Davidson, 1965; Askov & Fishbach, 1973; Rowell, 1972-1973; Nielson, 1978; Roettger, Szymezuk & Millard, 1979; Tocci & Engelhard, 1991). According to some researchers, the correlation between attitudes towards reading and achievement in reading is often demonstrating 10% or less common variance between the variables (Greenberg, Gerver, Chall & Davidson, 1965; Askov & Fishbach, 1973; Rowell, 1972-1973; Nielson, 1978).

Much of the studies in the area of reading indicated that attitudes towards reading influence achievement in reading. That is, the positive attitudes towards reading contribute meaningfully to higher achievement in reading (Schofield, 1980; Quinn & Jadav, 1987; Papanastasiou, 2002). On the other hand, some of the researchers suggested that there is not a causal relationship between attitudes towards reading and achievement in reading. Because of the correlation between these variables, attitudes towards reading do not appear to be causally related to achievement in reading (Roettger, Szymezuk & Millard, 1979; Quinn & Jadav, 1987).

The relationship between the student-teacher relations and the achievement of the students is generally positive. Indeed, the interactions of the students with their teacher affect the student performance (Hill & Rowe, 1996; Rowe, 1997a; Hill & Rowe, 1998).

There are inconsistent findings about the relationship between teacher-student relations and mathematical literacy across the countries based on the results of the report of PISA project. Since the teachers typically use more supportive practices in classes attended by a majority of less able students, the correlation between the support of the teacher and the performance of the students would be expected to be negative. On the other hand, to the extent encouragement is offered is effective, performance of the students would be expected to be higher in classes that receive more support than in other classes (OECD Publications, 2001).

Willms (1992) suggested that the school climate variables are strongly related to students' schooling outcomes, particularly academic outcomes of the students. In many countries, the perceptions of student-related factors affecting school climate are closely related to student performance (OCED Publications, 2001). Like many studies indicated, the climate variables have a direct influence on student achievement (Brookover, Beady, Flood, Schweitzer & Wisenbaker, 1979; Teddlie & Springfield, 1973; Scheerens & Bosker, 1997; Bos & Kuiper, 1999).

Considering home environment, it is expected to be highly related with student performance. Besides, considerable previous studies have demonstrated that there is an important relationship between the parental involvement and academic success of the students (OECD Publications, 2001). Sewell and Hauser (1980) suggested that children's likelihood of success in school and work is affected by the differences in the values, expectations and skills that parents may transmit to them. Thus, the communication with parents has an effect on the achievement of the students (Nelson, 1984; Reynolds & Walberg, 1992; Tocci & Engelhard, 1991; Entwisle & Alexander, 1996; Ferry, Fouad & Smith, 2000).

When looked at the previous studies, inconsistent findings are found about the relationship between the school resources and student performance. Some researchers suggested that more resources do not yield performance gains for the students (Hanushek, 1989; Okpala, Okpala & Smith, 2001; Papanastasiou, 2002). In contrast, some studies indicated that educational resources such as computers, library and teaching materials including textbooks and multimedia resources for learning are closely related to performance. Indeed, resources do have an influence on student achievement (Greenwald, Hedges & Laine, 1996; Oaker, 1989; D'Agostino, 2000; Schreiber, 2002).

Research studies indicated that the relationship between attitudes towards mathematics and achievement in mathematics is statistically significant and positive. Moreover, attitudes towards mathematics play an important role explaining achievement in mathematics (Suydam & Weaver, 1975; Sherman, 1980; Ethington & Wolfle, 1984, 1986; Lester, Garofalo & Kroll, 1989; Marshall, 1989; Eccles & Meece & Wigfield, 1990; Tocci & Engelhard, 1991; Reynolds & Walberg, 1992; Loebl, 1993; Bos & Kuiper, 1999; Abu-Hilal, 2000; Papanastasiou, 2000; Schreiber, 2002).

Some of the studies suggest that the correlation coefficients of attitudes towards mathematics and achievement in mathematics are used as measures of relationship. Therefore, there is not clear evidence in regard to whether attitude towards mathematics is a cause or an effect of achievement in mathematics. As a result, specifying any unidirectional causal relationship between these factors would be inappropriate (Neale, 1969; Enemark & Wise, 1981; Ethington & Wolfle, 1986; Quinn & Jadav, 1987).

The studies, believing the inappropriateness of the unidirectional causal relationships between these variables, indicated that there is a reciprocal or interactive nature between the attitudes towards mathematics and achievement in mathematics. According to these studies, modification the causal relationship of these variables can be applied by using a reciprocal relationship. Therefore, reciprocal relationship should be used in order to present the causal relationship of the attitudes towards mathematics and achievement in mathematics. (Marsh, 1986; Eccles & Meece & Wigfield, 1990; Tocci & Engelhard, 1991; Reynolds & Walberg, 1992; Ma, 1997; Abu-Hilal, 2000; Schreiber, 2002).

As known, education is a complex phenomenon, which a single indicator is not able to provide information about it. Therefore, a model is required in order to examine the factors affecting performance at the same time. A model allows not only for the examination of each construct's association with performance, but also for the exploration and examination of the relationships among those constructs.

Unfortunately, in Turkey, there is no research on modeling of the factors affecting the performance of the students in mathematical literacy. There is only a research study conducted on modeling of the relationship between the attitudes towards mathematics and achievement in mathematics (Tağ, 2000). However, there are several research studies on modeling in Science Education and Foreign Language Education (Tosunoğlu, 1993; Berberoğlu, 1995; Süleymanoğlu, 1997; Berberoğlu, 1999).

Consequently, there is a need for studying on modeling of the factors affecting mathematical performance of the students. Thus, the purpose of the present study is to investigate the factors affecting students' mathematical literacy across different cultural settings. This study is conducted on modeling of the identified factors by the previous studies that have important effects on the performance of the students in mathematical literacy. The basic variables in the examination of the effects on mathematical literacy are the attitudes towards reading, student-teacher relations, climate, communication with the parents, usage of technology and facilities, attitudes towards mathematics and reading literacy. Reading literacy is included in the model of factors affecting mathematical literacy because language plays an essential role in the communication of the mathematical ideas and relationships.

1.5.1 Purpose of the Study

The factors affecting mathematical literacy were tested with the framework of the model presented (Figure 1.1). This model was tested across three different cultures with different performance levels in PISA 2000 study. These are Brazil, Japan and Norway. The countries were selected on the basis of their rankings in the PISA 2000 study. Thus, Japan represented a high performing country with an average score of 557, Norway represented an average performing country with an average score of 499, and Brazil represented a low performing country with an average score of 334. Therefore, the countries included in this study were chosen to represent high performing, average and low performing countries, correspondingly, on the PISA 15-year-old students' mathematical literacy assessment. Furthermore, the educations in Brazil, Japan and Norway will be briefly presented in the literature review section of the thesis.

Ho: The model between ATTREAD, RELATION, CLIMATE, COM, USAGE, ATTMATH, READLIT and MATHLIT is not statistically significant.

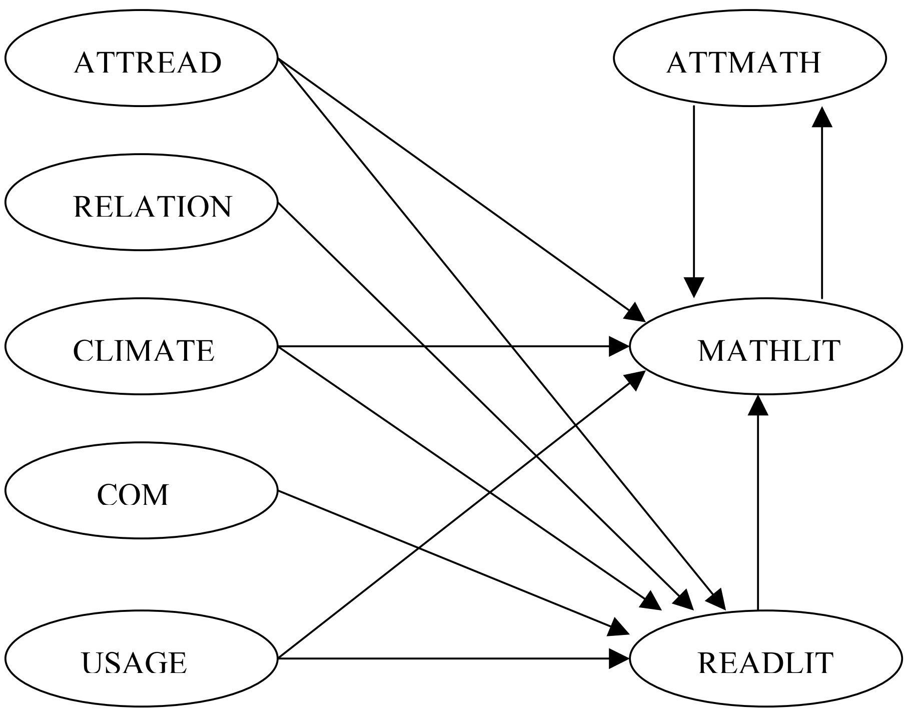

Figure 1.1 Hypothesized Mathematical Literacy Model

1.5.2 Definition of Important Terms

1. Student-Teacher Relations

The literature suggests the importance of the teacher behaviors. When the teacher is interested in the progress of the students and shows a willingness to help the students, students can benefit from the teaching practices. In PISA student questionnaire, the students were asked to indicate their ideas about the relationship between themselves and their teachers. They disagreed or agreed the given statements in the item.

2. Climate

The learning or disciplinary climate is another element of success of the students at school. The climate can affect the learning of the students with respect to their learning styles. Therefore, the climate at school is an important factor for the learning and the success of the students. In PISA student questionnaire, some of the statements were about the general view of the climate at school. The students selected the frequencies of the statements in the item.

3. Communication with the Parents

An essential element of success of the students at school is parents' support for their children's education. When the parents interact and communicate well with their children, they can have information about how their children are doing both in and out of school. Therefore, they can encourage and motivate their children with their interest. Previous research suggested that there is an important relationship between the parental involvement and the children's success. In PISA student questionnaire, students were asked some statements in order to get information about the interaction and communication with their parents. These statements indicated the cultural and social communication with their parents. The students selected the frequencies of the statements in the item.

4. The Usage of Technology and Facilities

The availability of a physical infrastructure and the adequate supply of educational resources are important for education. These can affect the performance and the learning of the students. The physical environment such as buildings in good condition and adequate amounts of teaching space is related to learning. Moreover, the adequate educational resources such as computers, calculators, library and teaching materials are also conducted to learning as well. In PISA student questionnaire, the statements indicated information about the physical environment and educational resources. The students selected the frequencies of the statements in the item.

5. Attitudes

The students setting their own learning goals and having a sense that they can reach these goals are potential learners. Motivation and engagement play an essential role in the students' quality of life. In addition, enjoyment of learning and activities promoting learning has an effect on motivation. The interest of the students in particular subjects is independent of the general motivation of the students to learn. The degree and continuity of engagement in learning and the depth of understanding reached are affected by the interest in particular subjects. Furthermore, the positive activities and engagement in particular subjects are not only essential for education, but also they are the predictors of learning success throughout the life. In general, the interest, motivation, enjoyment and engagement in particular subjects show the attitudes of the students towards the particular subjects.

In order to represent the attitudes of students towards reading and mathematics, some statements from the PISA student questionnaire and from the PISA cross-curricular competencies questionnaire were selected, respectively. The selection of the statements asked in questionnaires was made by the consideration of the interest, engagement and enjoyment in reading and mathematics. These selected statements were included in latent variables named attitudes towards reading and attitudes towards mathematics. The students disagreed or agreed the given statements in the items in questionnaires.

1.5.3 Significance of the Study

As presented before in this section of the thesis, a few studies were conducted about the PISA project. In addition, these studies were generally informative studies about the PISA project. One of the reasons of conducting a few studies about PISA project was that the first PISA study was conducted in the year 2000 and in the year 2003, it is repeated. Thus, the PISA study is a new international project. Consequently, the present study can be accepted as one of the first studies about the PISA project.

The PISA study is important because of being an international study. The international studies like PISA provide a base for both the international comparisons of the performance of education systems and the investigation of the assumptions about the quality of their own country's educational outcomes. In the international context, PISA provides strong, cross-culturally valid measures of competencies that are relevant to everyday life. Moreover, in the specific cultural context of a single country, PISA yields information to look closely at the factors associated with educational success.

The PISA study is also essential because of the assessment of the literacy domains. Generally the studies so far assessed the achievement in particular subjects. PISA project differs from these studies with respect to the assessed outcome in the study. As literacy concept is presented before in this section of the thesis, literacy is a lifelong learning in which new knowledge and skills necessary for successful adaptation to a changing world are continuously acquired throughout life. Thus, the PISA study assessed the ability of the students to complete tasks relating to real life depending on a broad understanding of key concepts rather than assessing the possession of specific knowledge.

The present study tries to model the factors affecting mathematical literacy of 15-year-old students across different cultural settings through the use of the data from PISA project. The countries included in this study were chosen to represent high performing, average and low performing countries, correspondingly, on the PISA 15-year-old students' mathematical literacy assessment. So, Japan represented a high performing country with an average score of 557, Norway represented an average performing country with an average score of 499, and Brazil represented a low performing country with an average of 334. Thus, the countries were selected on the basis of their rankings in the PISA 2000 study. Therefore, the study will examine how the students from these countries are different on the variables included in the study. However, according to the common results obtained from the three countries, general pattern can be drawn about the factors affecting mathematical literacy. On the basis of the general pattern, more information will be obtained on how to improve the performance of the students in mathematical literacy.

Furthermore, the PISA 2000 database is quite comprehensive to test different cultural settings. The results might provide a general model that could be used by educators and policy makers to enhance the students' literacy experience across the different cultural settings.

In addition, the findings of the study will be tested and more studies will be conducted after the PISA project is performed in Turkey and the data of Turkey is obtained.

CHAPTER 2

LITERATURE REVIEW

This chapter is devoted to the presentation of the previous research in the literature related to the present study. This chapter includes the studies conducted for Programme for International Student Assessment (PISA), the general information about the education in the countries, Brazil, Japan and Norway which were contained in the present study, the studies concerning the relationships between the variables in the study and the previous studies using structural equation modeling.

The questions in PISA were prepared in accordance with the situations in real life. The texts, lists, forms or diagrams in the questions were representing real life situations. Not only the knowledge and skills of the students, but also the ability of the students to reflect their knowledge and skills to the real world issues were assessed in PISA. Basso and Bonotto (2001) suggested that the relationship between mathematics and reality has always been both intricate and intriguing, as much complicated as interesting to deal with. Mathematics, although feeding off reality, detaches from it as soon as possible, due to its special nature, to come back to real experience in due time to pick up new problems or examples or to find new applications. Furthermore, the perception of the relationship is changing with developments in mathematics, such as those emanating from the increasing power of computers as manipulators of numbers, then symbols, then images. In addition, in common teaching practice, the habit of connecting mathematics classroom activities with reality is still substantially delegated to wor(l)d problems. Word problems often the sole example of realistic mathematical modeling and problem solving, at least in the teaching theory and practice of many teachers, in representing the interplay between mathematics and reality. Bringing real-world situation into school mathematics is a necessary, although not sufficient, condition to foster a positive attitude towards mathematics.

Briggs, Kolstad and Whalen (1996) suggested that in the past, children were confronted with language arts and mathematics as two unrelated fields, real worlds. This division was not necessarily wrong, but it placed at great disadvantage children who experienced mathematics as cold, threatening. Conversely, many children had difficulty reading, a topic where time allotment was restricted. To remedy both problems simultaneously, mathematics became less of a pure numbers exercise and more of a speaking, reading enterprise, which basically is the way practical mathematics is presented in everyday life. The National Council of Teachers of Mathematics (NCTM) has recommended that the mathematics curriculum include development of language and symbolism to communicate mathematical ideas and relationships (Grossman, Smith, & Miller, 1993). In order to uphold the NCTM recommendations, students must learn to communicate mathematically, in writing and through oral language (Capps & Pickreign, 1993). Studies support the benefits of incorporating reading, writing, and oral language into mathematics instruction to help students convey mathematical information in familiar words and assist them with their thinking processes, as they work through math calculations and problem solving situations. In addition, the students' abilities to communicate mathematically will improve by including oral language activities in mathematics lessons (Briggs, Kolstad, & Whalen, 1996).

2.1 Studies about PISA

An article was published examining the PISA project in some circumstances. These are the aim of PISA as the collection of the data on students' knowledge, skills and competencies in reading, mathematics and science for the OECD countries, the curriculum-focused and cross-curricular elements of PISA, and the assessment of

PISA with respect to defined content areas not narrowly defined subject matter knowledge, the investigated subjects in PISA such as how well young people are prepared to meet the challenges of the future, whether they have the capacity to continue learning throughout life, whether some kinds of teaching and organization are more effective than others. In addition, the article used the PISA data in order to compare the education in Britain with the educations in other countries (Fredriksson, 2001).

McQueen and Mendelovits (2003) discussed the steps taken to attain cultural relevance and appropriateness in the reading literacy construct and in the stimulus materials and items which operationalize it. The article explained the influence of multilingual considerations on the development of the reading literacy assessment instrument and noted some psychometric procedures used to maximize the validity of the instrument in an international context.

Taylor and Francis Group (2002) published an article explaining the properties of PISA and the report, Knowledge and Skills for Life-First Results from PISA 2000. The article focused on the property of PISA as not being a one-off study, being a study to be repeated every three years in order to measure changes in pupils' achievements over time. The article also examined the domains to be measured in every three-year-period. In addition, the article looked over the first cycle by using the report, Knowledge and Skills for Life, which gives information about the first cycle of the PISA project.

Grisay (2003) described the procedures implemented by the PISA International Co-ordination Center for the development of national versions of the assessment instruments in all instruction languages used in the participating countries. Moreover, the article gave information in presenting data that provide some empirical information on the effectiveness of the procedures; developing two source versions, in English and French; producing two independent translations, one from the English and the other from the French source version, of the assessment material into the language of instruction in their country; reconciling them into a single national version; and checking the equivalence of all national versions against the source versions.

In the present study, the model proposed on Programme for International Student Assessment (PISA) was tested in Brazil, Japan and Norway. In order to set a base for the further discussions of the results, the educations of these countries will be shortly presented in this section of the thesis.

2.2 Education in Brazil

The Brazilian education system is divided into three parts as basic education, middle education and higher education. Children are expected to stay in school for 4 years so as to finish the first and second cycles (1^{st} to 4^{th} grades), another 4 years to finish the third and fourth cycles (5^{th} to 8^{th} grades) of basic education and further 3 years to finish the middle education; adding up, therefore, to a total of 11 years. Nevertheless, for a number of reasons, ranging from the lack of openings into public schools, a series of school failures and even the need for premature engagement in the work force to contribute to family income, many children are not able to finish middle education (Mendes, & Utsumi, 2000).

Brazil is made up of 27 states and more than 4500 municipalities with the responsibility of providing primary education, while the states and federal government provide secondary education. One of the main problems in the school system in Brazil is school failure and grade repetition. Some of the determinants of school failure and grade repetition such as, for instance, malnutrition, clearly cannot be related to the school system and have to do with social and economic status. Many poor families have such low incomes that they have difficulty in keeping their children in school and out of the workforce. In many cases, children start working at a very early age in order to help their parents to earn money to make a living. However, explanations for school failure and grade repetition can also be related to the general low quality of some schools. There are unprepared teachers with low levels of education, low salaries and few material resources such as textbooks and audio-visual equipment. The working conditions in classrooms are also poor. Altogether, these factors contribute strongly to the teachers' and students' lack of motivation (Marcondes, 1999).

Marcondes (1999) suggest that it is not necessary to have a university degree to become an elementary school teacher in Brazil. Instead, there is a special course for elementary school teachers, corresponding to high school level. The great majority of the students taking this degree are female students, and nowadays these future elementary school teachers come from low middle class families with little education and their choice of profession represents upward social mobility. Those teachers who have taken a complete degree, and who have attended better schools and are better educated, are mainly concentrated in urban areas in the South and Southeast regions of the country. Elementary school teachers with the lowest levels of education are found mainly in rural areas in the Northeast and Middle-West regions of the country, although in all regions, especially in rural areas, there is a high percentage of elementary school teachers who have not graduated and in some cases have not even finished their elementary education themselves. So these teachers have limited schooling, sometimes no more than three years of elementary school. This does not imply that the low educational level of these teachers makes them in any sense directly responsible for the poor results of the elementary education. Even those who are considered to be good teachers do not feel stimulated to do a good job. Besides, facing problems such as schools with few material conditions and resources, Brazilian teachers feel their careers have been undervalued. Salaries in Brazil are very low, varying from the equivalent of US$25-200 monthly, and their profession has a low status in society. Because of these bad conditions and poor pay, few people want to be teachers and many teachers have other jobs to complement their salaries. And, many teachers leave their present jobs as teachers to get other jobs with better salaries (Marcondes, 1999).

Marcondes (1999) also suggest that there were approximately 1 375 000 elementary school teachers in Brazil in 1994, according to the Educational Census of 1994. Among these teachers, 1 186 000 taught at public schools and 189 000 taught in private schools. Approximately, 280 820 of the total taught in rural areas and most of the time at schools where there was only one classroom. In such schools, the teacher has to teach several different levels at the same time in the same classroom, the so-called multi-grade class. The reason for this is the inadequate number of teachers for all grades, especially in rural areas.

According to IBGE/PNAD (1988), the great majority of the students in the public elementary school system come from the poor population. 54% of the Brazilian students from 0 to 14 years old come from families of very low income, less than $250 per year, and are concentrated in slums at the periphery of big cities. Educational data reveal that 90% of children in urban areas study at public schools. These children come from the poorest families and generally fail school examinations (Marcondes, 1999).

Marcondes (1999) suggest that teachers feel that they are not prepared to teach poor children, with economic, social and cultural background different from their own and most of the time they do not know how to teach poor children. Teacher education programmes take as reference the white, middle-class student. When teachers face a different reality, they think it is difficult and sometimes impossible to teach poor students because they imagine these students are incapable of learning and will fail anyway.

Quite often research findings do not reach school teachers. The communication and discussion of these research findings are restricted to meetings in which school teachers do not participate. Therefore, as the participation of school teachers in research meetings is restricted, the communication of research findings remains restricted to the academy. Most of the time, research on teachers is not made by teachers but is formulated by teacher educators or research experts on teachers, often ignoring the concrete reality of teachers and the ways they deal with the problems they have to face daily in the classrooms (Marcondes, 1999).

Research on teachers frequently blames the way they act in the classroom for the bad results of education. It is said that things go wrong because of the teachers' behavior and they are often reported in the academic research in a negative way. In consequence, teachers feel used by academic researchers as they allow them to be close to their work and at the time the research report is written they feel academic researchers are largely insensitive to the complex circumstances with which they are faced in their work and they frequently feel exploited by university researchers (Zeichner, 1995).

2.3 Education in Japan

Cultural values and social forms and conditions shape the schools of any nation, nowhere is that instantly clearer than in Japan. Many of Japan's cultural and social features may be the result of its geography. Japan is a group of islands with a land mass size of Montana. Its 115 million people live on 20% of this land, the rest is mountain. The people and their homes, gardens, farms, temples, businesses, and industries must be intricately fitted into the available space. For a thousand years, the Japanese have been practicing the construction of miniature worlds, a talent and inclination obvious in their art and industry, especially their intricately designed small cars and electronic components (Deasy, 1986).

Social rituals also make sense when a vast number of people are crowded into tiny areas. The Japanese bow is the best known element of an elaborate system of social greetings and formalities. This ritual politeness provides a comfortable set of ground rules for avoiding social conflict, encouraging order, and protecting the boundaries of social groups and ranks. As they enter public school, Japanese children are introduced to these practices and taught that harmony and order are social assumptions, not simply the rules of the school. Were this not true, the schools could not enforce the order that is obvious throughout Japan any more to maintain discipline and order when those values are not supported by a stable and predictable society (Deasy, 1986).

According to Deasy (1986) nothing is more striking to a visitor than the complexity and formality of the Japanese language in both its written and spoken forms. The speaking adjusts the language to the person being spoken to, not just through the addition of polite expressions, but by complete shifts in vocabulary and grammatical form. Talking to a friend is different from talking to a teacher. Thus, Japanese are said to spend their lives learning to read and write their own language.

Group activities in schools are followed by critiquing sessions in which classmates comment on the performance, and the performing group is asked to be self-critical. The comments invariably contain elements of praise. This is also true of classrooms, teachers search for reasons to give praise; no one is singled out for embarrassing, isolating criticism (Deasy, 1986).

The rigorous examinations that the Japanese must pass to enter high schools, colleges, and universities are not only academic hurdles but social doorways as well. Examinations in Japan are the sole criterion for admission, and failure to score at high levels is a personal and social burden of the executives of major (Deasy, 1986).

Traditionally, the Japanese have deeply valued the educated person and the process of becoming educated. It is important worthwhile, and a social expectation that one seeks to become educated regardless of social rewards. This in no way blunts the desire to pursue an education in a prestigious university and by so doing to reap later economic benefits. But it does support a cultural perspective, those who have achieved, deserve their status and economic reward. In addition, Japanese teachers are well paid and the profession is esteemed. Therefore, the educational contexts, school, juko, home, are stable, reinforcing environments, learning is highly valued, discipline is inculcated by a variety of crucial social forces, quality performance is expected from students. In short, the time for learning is structured and student attention focused by a complex system of cultural and social pressures (Deasy, 1986).

In both elementary and secondary schools overwhelmingly belonged to teachers lecturing to classes of 40 students. Besides, Japanese schools stress not only the academic subjects including arts as a major component, but also moral, physical, social, and cultural education. In the latter pursuit, Japanese students may spend more than 30 school days each year on field trips to cultural sites and institutions in their region (Deasy, 1986).

In Japan, the family is still stable and deep core of the Japanese society. Generally, it is the mother who watches over nightly homework, researches the public and private schools to decide which will best prepare her children for the university and college examinations, arranges their enrollment in juko, the supplementary private schools widely used to give added instruction in everything from dance to mathematics, and serves as a constant reminder of the children’s expected performance level. Therefore, women are expected to attend to the inner world of the family in which the education of children is a central concern (Deasy, 1986).

Reports that Japanese students do well on international mathematics tests are linked to these successes and provoke the growing insistence in this country that more mathematics and science should be taught (Deasy, 1986). Japanese children have performed well in the international mathematics and science tests organized by the IEA, most recently the Third International Mathematics and Science Study (TIMSS), carried out in 1994-1995 and the TIMSS Repeat Survey carried out in 1999 (Cave, 2001).

2.4 Education in Norway

Norway has a long a tradition of a centralized education system and national curricula, the first curriculum dates back to 1891 when the Ministry of Church and Education recommended common subject content for all schools in the country (Hansen & Simonsen, 2001). The Education Acts stimulate that the school shall be founded on Christian belief and morals, democratic ideas, human rights and scientific thinking and method (Royal Ministry of Church and Education, 1987). An important principle in the Norwegian National Act of Education (1999) is that the school must value and treat every child as an individual; the mode of teaching must not only be adapted to subject and content, but also to age and maturity, the individual learner and the mixed abilities of the entire class (Royal Ministry of Church, Education and Research, 1993, p19). It is laid down in the new Act that all children irrespective of where in the country they live, and irrespective of gender, social, cultural, and economic background, have a right to equitable education (Hansen & Simonsen, 2001). A main principle in Norwegian basic school is that every pupil should have education in accordance with his capability and qualification. Stated in the central Act of the Basic School, and the fundamental of all basic teaching, this means that every pupil, whatever his capabilities or need, shall be given education accordingly (Holm, 2002).

The school buildings and grounds provide an important framework for this environment. The conditions under which the pupils learn are also determined by how pupils are grouped, and the arrangements made to provide opportunities for social contact and joint activities. It is an environment that stimulates learning and personal development and provides a foundation for positive development of identity (Hansen & Simonsen, 2001).

The interaction between teachers and pupils is of fundamental importance in providing a feeling of wellbeing in the learning environment and for determining how much pupils benefit from the teaching. It is vital to develop good forms of communication and co-operation between teachers and pupils and also between pupils themselves. It is important for professional teachers to understand how they can shape a good learning environment through a variety of methods and means of expression, by creating good social interaction and grouping of pupils, and by the appropriate organization of every pupil's work. In addition, the teachers in Norway are mentors, masters and mothers since the mandate and the subject content require a master; understanding the pupils and creating a good learning environment require both a master and a mother; and coping with more free organized learning activities requires both a mentor and a mother (Hansen & Simonsen, 2001).

Schools in Norway are required to be grounded in the fundamental values of democracy and human rights. The rule of law, freedom of religion, organizational freedom, and freedom of speech are of central importance in this regard. Equality of opportunity could only be achieved by creating a school for all learners, requiring everyone to participate in a very similar course of studies, at least through some basic school period (Hansen & Simonsen, 2001).

Not only the teachers required to choose between different teaching methods, but they must also make decisions concerning every aspect of schooling. Teachers are given much autonomy and expected to be professional in their wok. The national curriculum framework assumes that the professional teacher is one who has thorough knowledge and skills in didactics, pedagogy, in the history of ideas, in the history of education, and very importantly, a knowledge in the subject to be taught (Hansen & Simonsen, 2001).

In 1997, the age for school entry was lowered from 7 to 6 years. Before the child reaches this age, parents are given the opportunity to let their children enter kindergarten from the age of about 1 year on a fee-paying basis. In addition, in 1997, compulsory or basic school, where attendance was mandatory, was extended from 9 to 10 years, and divided in three parts as the middle school, lower secondary school and upper secondary school. Earlier, the 9 years of study were divided into two parts, primary and lower secondary school, 6+3 years. Upper secondary school consists of both general theoretical training, a gateway to the university; and vocational training (Hansen & Simonsen, 2001).

College-based teacher education is directed to the primary and lower secondary school while university-based programmes are directed primarily to the upper secondary school, although a considerable number of teachers with this education work in the lower secondary school. Since the 1990s, teacher education has been extended on two occasions, first to a 3-year course, where only students who had graduated from upper secondary school were admitted. In 1992, the training programme was extended to a 4-year course of the study (Hansen & Simonsen, 2001).

2.5 The Relationships of the Variables

2.5.1 Attitudes towards Reading

Autonomous learning requires both a critical, realistic judgment of the difficulty of a task and the ability to invest enough energy to accomplish it. These skills are the product of learning habits developed and shaped, among other things, by regular exposure to school tasks and teachers' evaluation of school work. Both enjoyment of learning and activities that promote learning enhance motivation. Interest in particular subjects affects both the degree and continuity of engagement in learning and the depth of understanding reached. This effect is largely independent of students' general motivation to learn. Hence, an analysis of the pattern of students' interest in various subjects is of importance. The results of PISA show that within countries students with a greater interest in reading tend to achieve better results than those with less interest. The causal nature of the relationship may well be complex and is difficult to discern. Interest in the subject and performance may be mutually reinforcing. Whatever the nature of the relationship, a positive disposition to reading remains an important educational goal in the own right (OECD Publications, 2001).

Deck and Barnette (1976) found correlations ranging from -0.22 to 0.32 between attitude towards reading and scores on a reading achievement test. In discussing these inconsistent correlations, they suggested that the hypothesized role of attitudes in the development of reading skills should be subjected to a more rigorous examination.

In the area of reading, Roettger, Szymezuk and Millard (1979) found statistically significant correlations of 0.317 and 0.315 between reading attitude and two measures of reading achievement. However, they concluded that because of this level of correlation, attitude would not be very useful as a predictor of reading achievement.

Schofield (1980) suggested that much of the research in the area of reading, attitude is based on the assumption that attitudes towards reading influence achievement in reading.

Many researchers studying reading had hypothesized that a positive student attitude towards reading contributes meaningfully to higher achievement in reading (Quinn & Jadav, 1987).

From these and other studies (Greenberg, Gerver, Chall & Davidson, 1965, Askov & Fishbach, 1973, Rowell, 1972-1973, Nielson, 1978), it appears that the correlation between reading attitude and achievement is most often positive, but often demonstrating 10% or less common variance between these variables.

2.5.2 Teacher-Student Relations

The results of some research provided strong support for the proposition that it is the identity of the class and teacher groups to which students in elementary schools have been assigned, which is the key determinant of their perceptions and experiences of schooling, as well as their academic achievement progress (Hill & Rowe, 1996, Rowe, 1997a). Consequently, the teachers can and do make a difference.

Hill and Rowe (1998) emphasized the importance of accounting for inter-relationships among factors operating within class and teacher groups affecting the experiences of individual students and the classes to which they belong.

To the extent that the teachers typically use more supportive practices in classes attended by a majority of less able students, the correlation between the support of the teacher and the performance of the students would be expected to be negative. At the same time, to the extent that the encouragement offered is effective, performance of the students would be expected to be higher in classes that receive more support than in other classes. Many factors may contribute to this pattern, and further research is needed to explore these. In the countries with below average, levels of teacher support and a negative relationship with performance is found. Supportiveness may be included in teachers' professional culture to a lesser extent than in other countries, and teachers may tend to limit their efforts to classes or individual students experiencing the most serious difficulties. Or perhaps, it is only once a critical mass of teacher support is provided in a school that the effects on student performance become sufficiently beneficial to have positive impact on student performance (OECD Publications, 2001).

2.5.3 Climate

Willms (1992) suggested that the school climate variables are strongly related to students' schooling outcomes, particularly academic outcomes of the students.

Like many schooling studies indicated, school-level variables have had direct effects on student achievement, independent from the teacher effects (Brookover, Beady, Flood, Schweitzer & Wisenbaker, 1979, Teddlie & Stringfield, 1993).

In the review of Scheerens and Bosker (1997), school climate from a list of school level factors is presented with a direct influence on student achievement.

In many countries, the perceptions of student-related factors affecting school climate are closely related to student performance. The relationship between students' perceptions of disciplinary climate and the performance of the students is clearly visible in many countries (OECD Publications, 2001).

2.5.4 Communication with Parents

Sociologists argue that children's likelihood of success in school and work is affected by the differences in the values, expectations and skills that parents may transmit to them (Sewell & Hauser, 1980).

Families that are cohesive, socially integrated, and well-organized tend to promote students' scholastic self-concepts, while highly conflicted and controlling families do not (Nelson, 1984).

Reynolds and Walberg (1992) specified a structural order to the model in which the factors contribute to mathematics achievement and attitude in diverse ways. They found that home environment has pervasive effects on the achievement of the students.

Parents' support for their children's education is an essential element of success at school. When the parents interact and communicate well with their children, they can offer encouragement, demonstrate their interest in their children's progress, and otherwise convey their concern for how their children are doing, both in and out of school. Besides, considerable previous research has demonstrated that there is an important relationship between the parental involvement and children's academic success (OECD Publications, 2001).

2.5.5 Usage of Technology and Facilities

There are many studies investigating the institutional factor, resources (Hanushek, 1989; Greenwald, Hedges & Laine, 1996). Numerous studies in Hanushek's review (1989) had either significantly positive or negative results, or non-significant positive and negative results. He concluded that no strong or consistent relationship exists between the school resources and student performance and that more resources would not yield performance gains for the students. Greenwald, Hedges and Laine (1996) performed a meta-analytic review of the studies from the Hanushek's review and more recent articles. They concluded that resources do have an influence on student achievement. Neither study focused on the impact of resources on student variables that could affect performance.

The availability of a suitable physical infrastructure and an adequate supply of educational resources may not guarantee high performance, but the absence of such an environment that buildings in good condition and adequate amounts of teaching space is conductive to learning. In addition, schools with adequate educational resources such as computers, library and teaching materials, including textbooks and multimedia resources for learning are closely related with learning (OECD Publications, 2001).

Resources translate into learning opportunities, and these opportunities are what make a difference for the students and are an enabling condition that allows curricula to be implemented. Schools that have substantially fewer resources provide less access to mathematics knowledge, or access is substantially reduced for their students. The lack of access, or opportunity to learn, can detrimentally affect achievement (Oaker, 1989).

Physical infrastructure is at most weakly associated with performance of the students. On the other hand, educational resources appear to be more closely related to performance than physical infrastructure (OECD Publications, 2001).

2.5.6 Attitudes towards Mathematics

According to Ma (1997), attitude towards mathematics is either positive or negative responses, in terms of importance, difficulty and enjoyment, when learning mathematics.

Suydam and Weaver (1975) suggested that teachers and other mathematics educators generally believe that children learn more effectively when they are interested in what they learn and that they will achieve better in mathematics if they like mathematics. Therefore, continual attention should be given for creating, developing, maintaining and reinforcing positive attitudes.

Research studies indicated that attitude towards mathematics plays an important role in explaining achievement in mathematics (Ethington & Wolfle, 1984, 1986; Lester, Garofalo & Kroll, 1989; Loebl, 1993; Marshall, 1989; Sherman, 1980).

Most studies use correlation coefficients as measures of the relationship and therefore do not provide clear evidence in regard to whether attitude towards mathematics is a cause or an effect of achievement in mathematics (Enemark & Wise, 1981; Neale, 1969).

Ethington and Wolfle (1986) discussed the relationship between mathematics attitude and exposure. Although it is said that enrollment in mathematics courses is likely to affect attitudes toward mathematics, an equally plausible argument may be made that these attitudes affect decisions to enroll in mathematics courses. Thus, specifying any unidirectional causal relationship between these factors would be inappropriate.

Since more learning takes place in school in the case of mathematics than in that of reading, such differences between countries may suggest that education systems have an impact on the attitudes of young people towards mathematics. This, confirmed by further research, will be an important finding for education policy. Given the increasing importance of mathematics for students' future lives, it is of great importance for education systems to ensure that students have both the interest and the motivation to continue learning in this area beyond school. While the pattern varies between countries, within countries the relationship between interest in mathematics and performance in mathematical literacy is positive, albeit less pronounced than in reading (OECD Publications, 2001).

2.6 Previous Studies

2.6.1 Related Studies

The purpose of the study, conducted by Quinn and Jadav (1987), was to explore possible causal relationships between attitude and achievement in the subjects of mathematics and reading for elementary school children. Cross-lagged panel analysis was performed as a secondary analysis of data from studies of elementary grade students. The analysis was conducted on measures from a total of 1 758 elementary students from the second to sixth grades. For the subjects and grade levels studied, liking activities related to a topic does not appear to be causally related to doing well in that topic. As a conclusion, no significant and predominant causal relationship between attitude and achievement was indicated. Subsequently, it was concluded that producing changes in one variable would not necessarily lead to changes in the other.

Tocci and Engelhard (1991) performed a study, the purpose of the study was to investigate the relationships of attitude towards mathematics with mathematics achievement, parental support, and gender. A secondary analysis was conducted using nationally representative samples of 13-year-old students, 3 846 students in the United States, and 3 528 students in Thailand, which were collected as a part of the Second International Mathematics Study (Garden, 1987). A multivariate general model was used to analyze the data within each country. Four attitude scales which were Mathematics and Myself, Mathematics and Society, Mathematics as a Male Domain and Mathematics Anxiety were used as the criterion variables. The Mathematics and Myself scale was designed to assess students' personal views of themselves as learners of mathematics. The extent to which students enjoy studying mathematics, feel confidence in their ability as learners of mathematics, and want to achieve in mathematics were reflected in the scale. The Mathematics and Society scale was designed to measure students' views of the usefulness and importance of mathematics to society. A positive view indicated that mathematics was seen as useful in everyday life and important in preparing for an occupation. The Mathematics as a Male Domain scale examined the extent to which mathematics was viewed by students as a male domain. And the Mathematics and Anxiety scale was designed to measure the extent to which the students were anxious about mathematics. Mathematics achievement, parental support and gender were used as the predictor variables. The Parental Support for Mathematics scale contained nine items designed to measure the students' perceptions of parental behaviors, including enjoyment when encountering mathematics, interest and ability to help their child with mathematics homework and encouragement to study and do well in mathematics. The results in both countries confirmed earlier research indicating a positive relationship between mathematics achievement and two of the attitudes, students who have higher scores on mathematics tests tend to have more positive perceptions of their encounters with and reactions to the subject of mathematics, and the usefulness of mathematics in society. In the study, parental behaviors do appear to be related to student attitudes towards mathematics. Some of the more permanent and important effects of attitude may occur because of factors in the home environment that are central to their developing value system. As a conclusion, achievement and parental support are significant predictor of attitudes towards mathematics, in both countries.

The study, conducted by Entwisle and Alexander (1996), investigated the family type and children's growth in reading and mathematics over the primary grades. In a random sample of Baltimore school children over the first 2 years of school, there are no direct effects of parent configuration on marks or test score gains in reading and mathematics. However, the children whose parents have higher expectations for their school performance consistently outperform other children in reading and mathematics. Both kinds of parents' expectations have significant and strong total effects on test score gains. Just like the children's reading performance, expectations variables explain the effects of family configuration on children's mathematics performance. Parents' expectations probably impel children to perform because they reflect a whole set of parental attitudes about and views of the child, but they also proxy specific steps parents take to help children do well. For instance, parents who have high expectations are more likely to provide opportunities for the child to learn at home. Adding parent expectation variables to models predicting test scores at the start of first grade increases the explained variance from 13% to 23% for reading, and from 31% to 44% for mathematics. As a conclusion, the stripped down models showed parents' psychological supports are important for children's school performance and are largely independent of their economic resources.

The purpose of the study, conducted by D'Agostino (2000), was to examine the effects of instructional and school organizational characteristics on the longitudinal mathematics and reading achievements of students from either a first-grade or third-grade cohort. Prospects, a data set on schools and students in the United States were collected during the early 1990s and this data was used in this study. Three schooling models were tested using hierarchical linear modeling (HLM) while controlling for parental socioeconomic status. The variables in the factor, school compositional effects were school size, days of school, urbanicity, poverty level, racial distribution, and student mobility. The variables in the factor, school organizational themes were stability and orderliness, social support and shared mission, and lastly decision-making, development and planning. The variables in the factor, instructional effects were basic-skill instruction, advanced-skill instruction, between-class grouping, in-class grouping, opportunity to learn, and homework. Factors and variables that represented instructional and school features were derived from teacher and principal responses to survey items. These features had direct and interactive effects on mathematics achievement, supporting both an environmental and interactive model of schooling. It is suggested that effective schools are successful at accumulating human resources, and they reach this state by fostering intragroup cohesion and morale. Good schools increase personnel commitment, and thus, motivate employees to achieve the organization's goals. As was evinced by the non-significance of the stability and orderliness composite, effective schools do not appear to focus on developing a formalized structure in order to create stability and predictability, as asserted by components of the continuity of the model. Perhaps, the greatest implication of these findings was that student achievement growth can be improved by modifying instructional practices and the school's organizational structure.

Okpala, Okpala and Smith (2001) investigated the influence of parental involvement, socioeconomic status of the parents and instructional supplies expenditures on mathematics achievement scores of grade 4 students in a low-income country in North Carolina. An educational production function framework was used to analyze the influence of educational resources on mathematics achievement scores. In addition, pearson product-moment correlation and ordinary least squares regression were used to determine the overall strength of each relation and the variables with the greatest impact on mathematics achievement. Instructional supplies expenditures per pupil are not significant for explaining changes in mathematics scores. This result did not clear the inconsistencies that exist in the literature concerning the impact of expenditures per student. Furthermore, this result supported the finding of other studies that increased educational expenditures will not enhance students' achievement scores.

Papanastasiou (2002) performed a study, the purpose of the study was twofold as to examine how the attitudinal and instructional variables differentiated 4th grade students in Cyprus, Hong-Kong, and the USA and to determine how these variables were related to mathematics performance on the TIMSS test. The countries were chosen to represent high performing, average and low performing countries, correspondingly, on the TIMSS fourth-grade mathematics test. Hong-Kong represented a high performing country, the USA represented an average performing country and Cyprus represented a low performing country. A discriminant analysis was performed to examine how those variables differentiated the students in the three countries. Extremely positive attitudes towards mathematics are held by Cyprus-like students. These are the same students who had the highest mathematics scores within each country. The less the students use computers in their classrooms, the higher their mathematics scores are. It is interesting that the highest means generally belong to students who have never used computers. In addition, the lowest mathematics score average belongs to the students who used computers for most of their lessons. The US-like students who use computers for some of their lessons have higher performance than the US-like students who use computers for most, or none, of their lessons. As a conclusion, 4^{th} grade students who like mathematics and who have not been taught using computers tend to be better students. A more important conclusion that can be drawn from this study is that the same variables do not always have the same effects on different students. In reality, patterns of the same variables can have very different effects on the students, depending on the cultural context that the students are in.

2.6.2 Related Modeling Studies using Linear Structural Relations Statistics Package Program (LISREL)

The previous modeling studies using Linear Structural Relations Statistics Package Program (LISREL) were presented in this section of the thesis. The presented studies here investigated the factors affecting mathematics achievement of the students. Modeling studies examining the performance of the students in mathematical literacy were not found. One explanation is that literacy is a new concept in education. Thus, the modeling studies found in the literature about the investigation of factors affecting the mathematics achievement were presented in this section of the thesis.

The purpose of the study, conducted by Marsh (1986), was to examine empirical support for the internal/external (I/E) frame of reference model that describes the relation between verbal and mathematics self-concepts, and between these academic self-concepts and verbal and mathematics achievement. The empirical tests were based on all studies that have employed the Self Description Questionnaire. The model of the study is displayed in Figure 2.1.

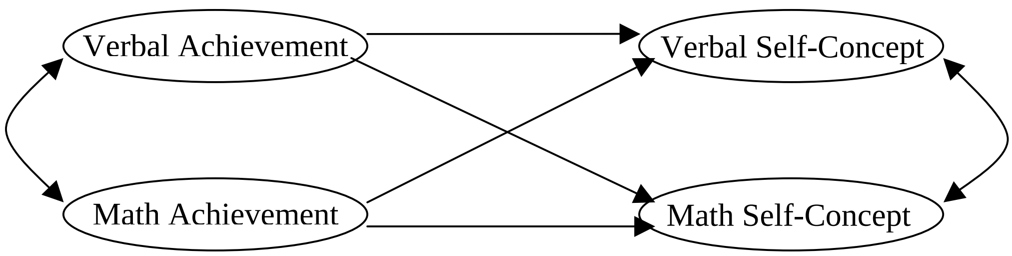

Figure 2.1 I/E Model of the Study (Marsh, 1986)

The I/E model was originally prompted by the observation that verbal and math self-concepts are relatively uncorrelated with each other, even though verbal and math achievement indicators are substantially correlated with each other and with the corresponding self-concepts. Despite high correlations between verbal and mathematics achievement indicators, and the significant correlation of each with the matching measure of academic self-concept, verbal and mathematics self-concepts are nearly uncorrelated with each other. Even though the mathematics and verbal self-concept correlation is significantly positive in some of these analyses, this correlation is substantially smaller than the mathematics and verbal achievement correlation. Furthermore, the direct effects of verbal achievement on mathematics self-concept, and the direct effect of mathematics achievement on verbal self-concept, are each significantly negative (Marsh, 1986).

Eccles, Meece and Wigfield (1990) used structural equation modeling procedures in order to assess the influence of past math grades, math ability perceptions, performance expectancies and value perceptions on the level of math anxiety in a sample of 250 students from 7th grade through 9th grade. A second set of analyses examined the relative influence of these performance, self-perception and affect variables on students' subsequent grades and course enrollment intentions in mathematics. Figure 2.2 presents the model of the study.

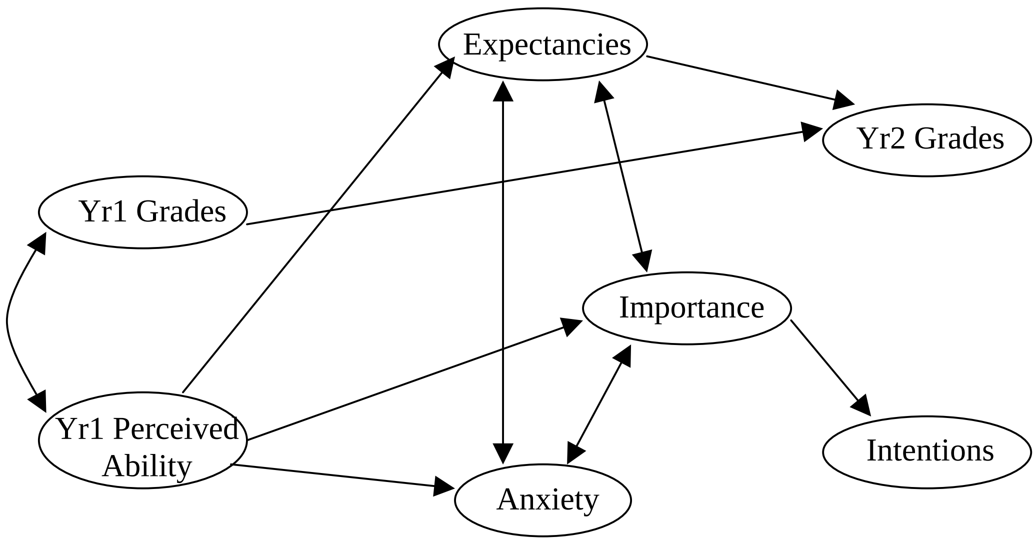

Figure 2.2 Model of the Study (Eccles, Meece and Wigfield, 1990)

The direct links between expectancies and Year 2 math grades are strong and positive, which indicates that students with higher performance expectancies in math have higher Year 2 grades. The results suggested that students' efficacy-related beliefs influence students' performances and academic choices in mathematics, as hypothesized. In addition, students' ability perceptions have strong direct effects on Year 2 performance expectancies, importance-ratings, but they have only indirect effects on Year 2 grades and intentions. As a conclusion, these results suggested that expectancy and importance ratings are stronger determinants of subsequent performance. The perceived value of mathematics may lead students to develop their mathematical skills and abilities, or students may come to value those skills and tasks they perform well (Eccles, Meece and Wigfield (1990).

Reynolds and Walberg (1992) conducted a study using a structural equation modeling with nine factors exert both indirect and direct effects on 7^{th} grade mathematics achievement and attitude. A national probability sample of about 2 500 high school sophomore mathematics students were used in the further testing of the model. A three-wave longitudinal design incorporated data from students, teachers and parents. The structural model, evolved and cross-validated with the younger sample, significantly and substantially accounted for variance in mathematics achievement and attitudes toward mathematics. Figure 2.3 displays the model of the study.

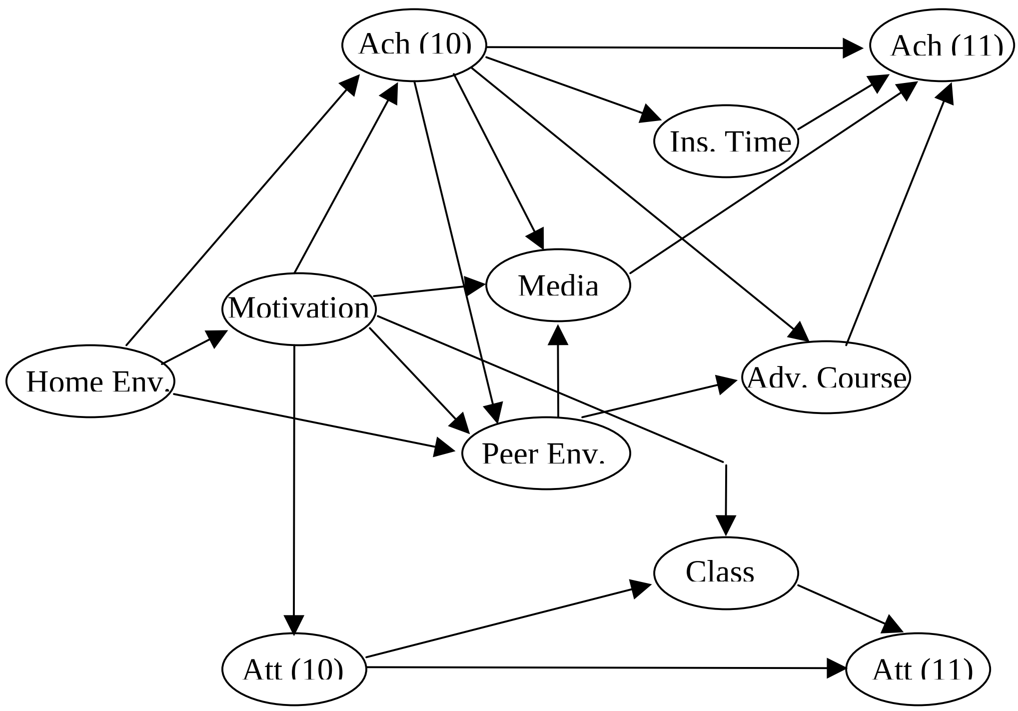

Figure 2.3 Model of the Study (Reynolds and Walberg, 1992)

Home environment has pervasive indirect effects on later achievement, and to a lesser degree, motivation. That result was expected, because children have been continuously exposed to the home environment since birth. Besides, prior attitude has small indirect effect on the achievement. On the other hand, the achievement-attitude relation suggested that the direction of the influence flows from achievement to attitude rather than the reverse. In addition, motivation and home environment have the greatest indirect effects on 11^{th} grade mathematics attitudes, primarily through complex paths involving prior attitude. As a conclusion, home environment and previous achievement have the largest effects on achievement, perhaps because they cumulate during the preschool and elementary school years. Nonetheless, the other hypothesized factors, motivation, mathematics attitude, classroom environment also have significant effects on outcomes (Reynolds and Walberg, 1992).

Ma (1997) suggested that mathematics educators have done little to investigate the reciprocal relationship between attitude towards mathematics and achievement in mathematics. In the study of Ma (1997), the reciprocal relationship was modeled, using data from a Dominican national evaluation of high school mathematics with a sample of 1 044 students. Three data sets that were used to examine a hypothesized causal model demonstrated relatively good results on model-data-fit. The model used in the study is presented in Figure 2.4.

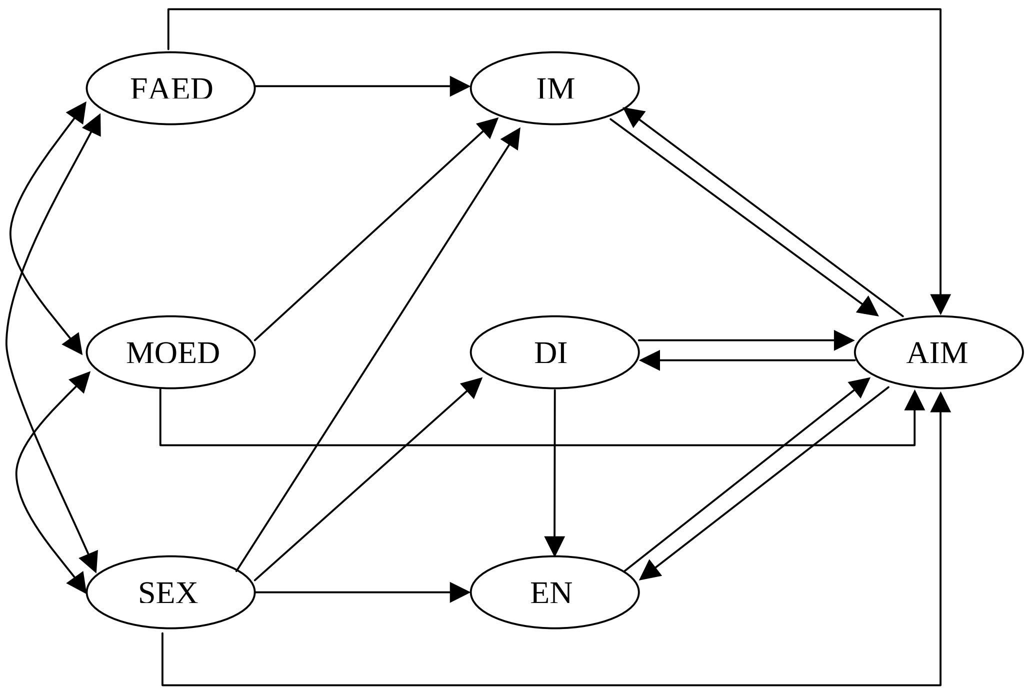

Figure 2.4 Structural Model of the Reciprocal Relationship (Ma, 1997)

A reciprocal relationship exists between every attitudinal measure and mathematics achievement. Moreover, the feeling of enjoyment, not the feeling of difficulty, directly affects mathematics achievement. On the other hand, the feeling of difficulty functions over the feeling of enjoyment to affect mathematics achievement. Furthermore, the perception of mathematics as important is independent of other attitudinal measures. As a conclusion, the findings suggested that the reciprocal or interactive nature between the attitude towards mathematics and achievement in mathematics can substantially modify their causal relationships. A unilateral relationship is likely to overestimate the causal effect between the attitude towards mathematics and achievement in mathematics (Ma, 1997).

Hill and Rowe (1998) suggested that long-standing and enduring problems in quantitative studies of educational effectiveness relate to fitting models that adequately reflect the complex inter-relationships among multivariate, multilevel factors affecting the students' educational progress, particularly among those that operate within classrooms. The article illustrated one approach to solving such difficulties by combining the analytic approaches of multilevel analysis and structural equation modeling in a two-stage process. The data used drawn from a longitudinal study of teacher and school effectiveness for three grade-level cohorts of 4 558 students clustered within 334 class or teacher groups in 52 elementary schools. The variables included in the model were critical events, inattentiveness, student attitudes such as enjoyment of school, teacher responsiveness, usefulness and two measures of student achievement in mathematics. The model of the study is given in the Figure 2.5. The results provided strong support for the proposition that it is the identity of the class or teacher groups to which students in elementary schools have been assigned that is the key determinant of their perceptions and experiences of schooling, as well as their academic achievement progress. In sum, teachers can and do make a difference. The importance of accounting for inter-relationships among factors operating within class or teacher groups affect the experiences of individual students and the classes to which they belong. As a conclusion, the finding that teacher responsiveness has strong effects on reducing their inattentiveness, together with the strong reciprocal effects between inattentiveness and mathematics progress, maximizes the progress of the students.

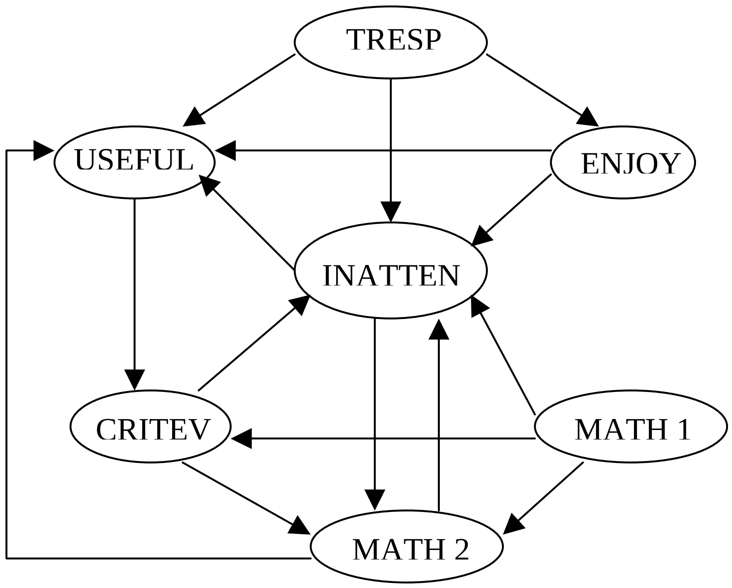

Figure 2.5 Schematic Multilevel, Structural Equation Model (Hill and Rowe, 1998)

Bos and Kuiper (1999) suggested that in international comparative studies like Third International Mathematics and Science Study (TIMSS), data analysis is aimed at differences and similarities among the education systems or the countries. In the study, the outcomes were presented of explorative path analysis on data collected with 8th grade students and classrooms in eight Western and two Central European education systems. For the 10 education systems, the resulting general path model explains 19% or less of the variance in achievement in mathematics. The model of the study is presented in Figure 2.6. The latent variables contained in the model were homework, teaching style, school climate, student's gender, maternal expectation, friends' expectation, success attribution mathematics, instructional formats, mathematics lesson climate, and attitude towards mathematics, home educational background, class size, effective learning time, assessment and out-of-school activities. In most of the 10 systems, attitude towards mathematics has a significant influence on achievement as a direct link. Attitude has a positive relation with achievement in 8 of the 10 systems, not in Germany and England. Class climate which was supposed to have a direct influence on achievement does not show a significant coefficient in the majority of the education systems, except for England with a significant path coefficient of 0.15. The percentage of the variance in class climate is explained by latent variables as homework, teaching style, school climate, friends' expectations and student's attitude.

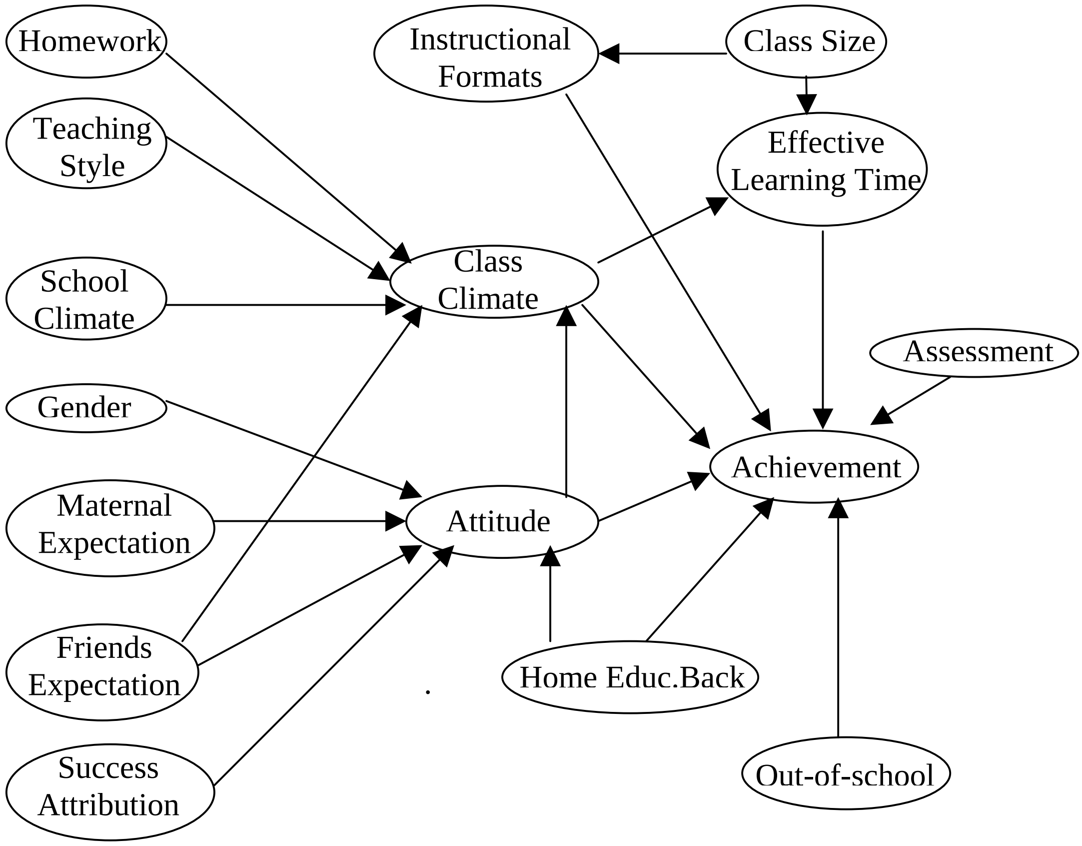

Figure 2.6 Recursive Student and Classroom Model (Bos and Kuiper, 1999)

In the study of Ferry, Fouad and Smith (2000), the effects of family context and person input variables on learning experiences, self-efficacy, outcome expectancies, interests and goals were examined. Data on 791 undergraduate students enrolled in psychology classes at two universities were collected. Results based on a revised path model provided empirical validation of the Lent et al. (1994) model for this college student population. In the revised model, the included variables were age, gender, parental encouragement (enc), grades in mathematics and science classes (gms), math-science self-efficacy (msse), math-science outcome expectancies (msoe), math-science interests (msint), and math-science goals (msg). The model of the study is displayed in Figure 2.7.

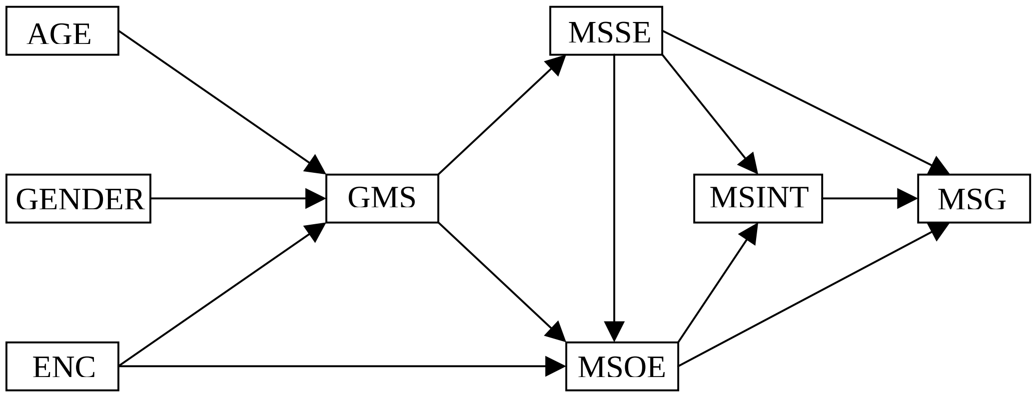

Figure 2.7 The Revised Model of the Study (Ferry, Fouad and Smith, 2000)

Parental encouragement in mathematics and science was found to significantly influence learning experiences. The magnitude of the path coefficient between encouragement and grades implies a causal link between encouragement and grades in mathematics and science. The more a parent is perceived as encouraging effort and experience in mathematics and science, the higher one's grades are in these areas. This result depicted the important influential role that parents' verbal suggestion, support, and domain-specific encouragement plays in their children's academic and career development. The significant indirect paths from encouragement to self-efficacy and outcome expectancies through grades was consistent with Lent and colleagues' (1994) hypothesis that contextual affordances inform learning experiences that predict self-efficacy and outcome expectancies. The relationships of mathematics and science grades to self-efficacy and outcome expectations illuminate the importance of performance accomplishments as a source of self-efficacy. Counselors can design, implement, and evaluate interventions that promote successful performance accomplishments and encourage students who have demonstrated prior achievement and aptitude in mathematics and science to participate in mathematics and science opportunities (Ferry, Fouad and Smith, 2000).

Abu-Hilal (2000) conducted a study in order to test a model of mathematics achievement and its relations to antecedent and subsequent factors using structural equation modeling. A sample of 394 elementary school students in Al-Ain school district completed an Arabic version of the self-description. Students completed a questionnaire including their perception of the importance of mathematics, anxiety about it and the amount of effort they exerted in studying. Mathematics grades were obtained from the official school records. The model of the study is displayed in Figure 2.8.

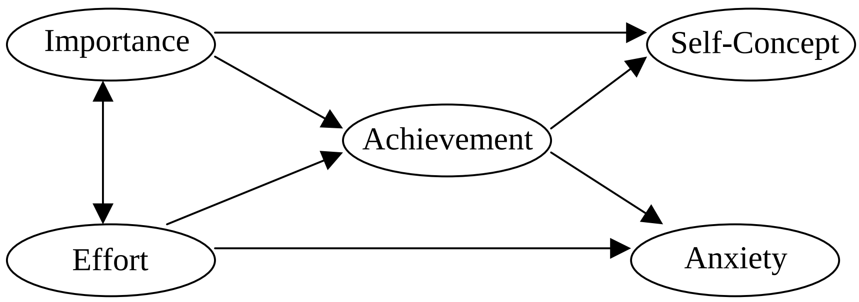

Figure 2.8 The Structural Model of Mathematics Achievement (Abu-Hilal, 2000)

The study provided a result that mathematics importance or attitude towards mathematics relates positively to achievement in mathematics. In addition, importance of mathematics is positively, directly and indirectly related to self-concept. Moreover, students who attach more importance to and perform well in mathematics tend to develop positive perceptions of their abilities.

Papanastasiou (2002) investigated the mathematics achievement of 8th grade students in Cyprus enrolled the Third International Mathematics and Science Study (TIMSS) in the year 1994-1995, using a structural equation modeling. The model contained two exogenous constraints, the educational background of the family and the reinforcement from mother, friends and the individual himself; and five endogenous constructs, socioeconomic status, student attitudes towards mathematics, teaching, school climate and beliefs related to success in mathematics. The model of mathematics outcomes process of the study is displayed in Figure 2.9.

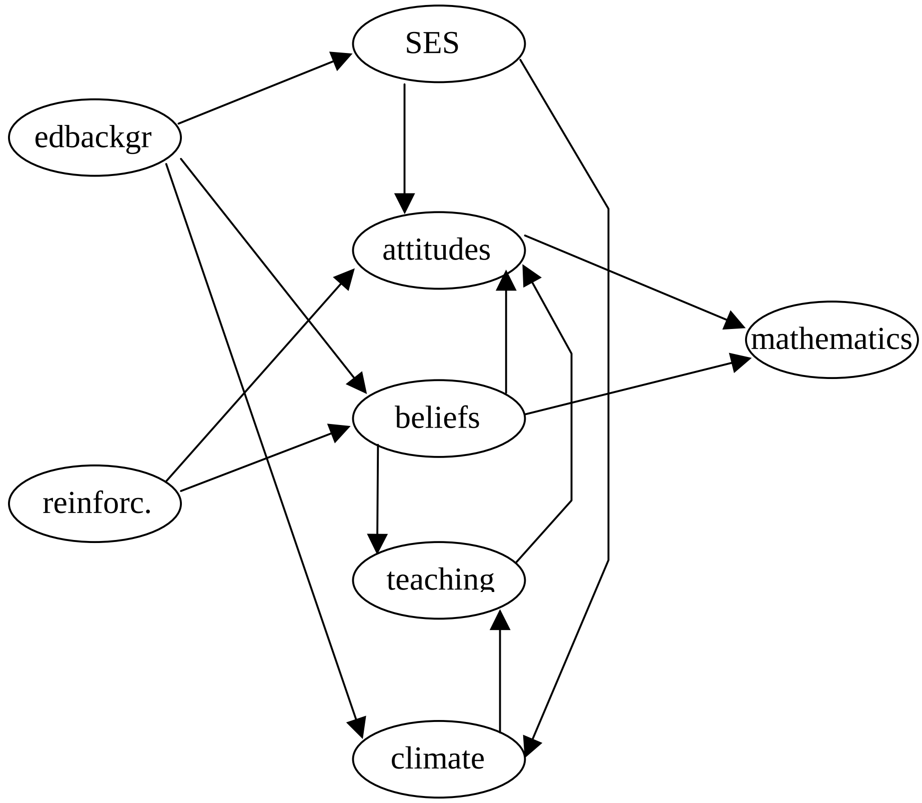

Figure 2.9 The Model of Mathematics Outcomes Process (Papanastasiou, 2002)

The study demonstrated that although attitudes, teaching and beliefs have direct effect on mathematics outcomes, they are not statistically significant. Although the attitudes are positive for the majority of the students, achievements of the students in mathematics do not follow the same pattern. The findings of the study indicated that more should be undertaken to examine the influence of attitudes on mathematics outcome. Papanastasiou (2000) suggested that a positive relationship is often observed between mathematics achievement and the students' attitudes towards mathematics. That is, students who do well in mathematics generally have positive attitudes towards the subject, and those who have positive attitudes tend to perform better. Papanastasiou (2000) was also conducted a study in which the same model was tested using the data from three countries, Cyprus, Japan and USA. In the study, the proposed model indicated that attitudes cannot be used to predict student outcomes in mathematics. As a conclusion, the attitudes towards mathematics are not found to be predictors of student achievement in mathematics in Cyprus, Japan and the US.

Schreiber (2002) examined advanced mathematics achievement with 1 839 students from 162 schools. The data were obtained from the Third International Mathematics and Science Study (TIMSS) 3rd population cohort. In order to examine the student-level and school-level factors, hierarchical or multilevel linear modeling was conducted. Figure 2.10 displays the model examined in this study.

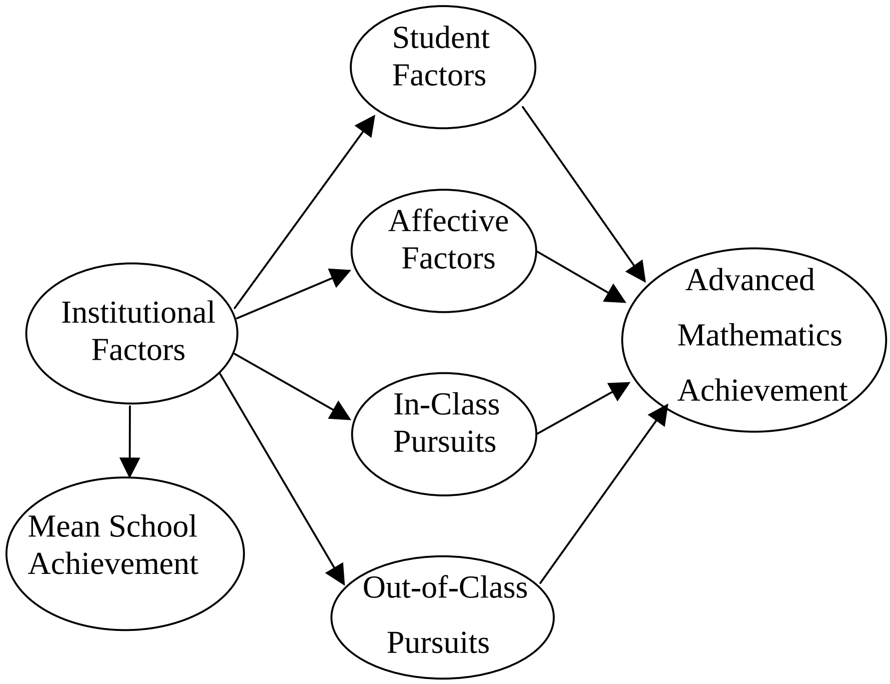

Figure 2.10 The Model Examined (Schreiber, 2002)

The results indicated a significant association between resources and mean advanced mathematics achievement. Overall, schools that have more resources have higher mean advanced mathematics achievement. The attitude-achievement slope coefficient indicated that, on average, student attitude towards mathematics is significantly and negatively related to advanced mathematics achievement. Because this item was reverse coded, the interpretation was that students with poor attitudes towards mathematics tend to perform lower on the test. This finding was important because it demonstrates that even the most advanced students’ achievement is associated directly with their attitude towards mathematics. The analysis technique for the study was unidirectional. Although this analysis regressed achievement on attitude towards mathematics, this does not negate the possibility that attitude towards mathematics and achievement are bidirectional. Specially, the relationship could work in a bidirectional spiral pattern in which success increases attitude, which increases success, and so forth. In essence, attitude towards mathematics and mathematics achievement are simultaneously building on each other (Schreiber, 2002).

2.6.3 Summary of the Findings of Previous Studies

1. The relationship between the attitudes towards reading and achievement in reading is statistically significant. The correlation between the attitudes towards reading and achievement in reading is often positive (Greenberg, Gerver, Chall & Davidson, 1965; Askov & Fishbach, 1973; Rowell, 1972-1973; Nielson, 1978; Roettger, Szymezuk & Millard, 1979; Tocci & Engelhard, 1991).

2. Attitudes towards reading influence achievement in reading. That is, the students having positive attitudes towards reading contribute meaningfully to higher achievement in reading (Schofield, 1980; Quinn & Jadav, 1987; Papanastasiou, 2002).

3. Some of the researchers suggest that there is not a causal relationship between the attitudes towards reading and achievement in reading. Because of the correlation between attitude and achievement, attitudes towards reading do not appear to be causally related to achievement in reading (Roettger, Szymezuk & Millard, 1979; Quinn & Jadav, 1987).

4. The relationship between the mathematics achievement and the verbal self-concept is significantly negative (Marsh, 1986).

5. The relationship between the student-teacher relations and the achievement is generally positive. The interactions with the teachers affect the student performance (Hill & Rowe, 1996; Rowe, 1997a; Hill & Rowe, 1998).

6. The perceptions of student-related factors affecting climate are closely related to student performance. The climate variables have a direct effect on student achievement (Brookover, Beady, Flood, Schweitzer & Wisenbaker, 1979; Willms, 1992; Teddlie & Stringfield, 1993; Scheerens & Bosker, 1997; Bos and Kuiper, 1999).

7. Home environment is highly related with student performance. There is an important relationship between the parental involvement and academic success of the students. Communication with parents has effects on the achievement of the students (Sewell & Hauser, 1980; Nelson, 1984; Tocci & Engelhard, 1991; Reynolds & Walberg, 1992; Entwisle & Alexander, 1996; Ferry, Fouad & Smith, 2000).

8. There is no strong or consistent relationship between the school resources and student performance. That is, more resources do not yield performance gains for the students (Hanushek, 1989; Okpala, Okpala & Smith, 2001; Papanastasiou, 2002).

9. Educational resources such as computers, library and teaching materials including textbooks and multimedia resources for learning are related to performance. Indeed, resources do have an influence on student achievement (Oaker, 1989; Greenwald, Hedges & Laine, 1996; D'Agostino, 2000; Schreiber, 2002).

10. The relationship between the attitudes towards mathematics and achievement in mathematics is statistically significant. Besides, the correlation coefficient between the attitude and achievement is positive. Thus, attitudes towards mathematics play an important role in explaining achievement in mathematics (Suydam & Weaver, 1975; Sherman, 1980; Ethington & Wolfle, 1984, 1986; Lester, Garofalo & Kroll, 1989;

Marshall, 1989; Eccles, Meece & Wigfield, 1990; Tocci & Engelhard, 1991; Reynolds & Walberg, 1992; Loebl, 1993; Bos & Kuiper, 1999; Abu-Hilal, 2000; Papanastasiou, 2000; Schreiber, 2002; Papanastasiou, 2002).

11. Some of the researchers suggest that the correlation coefficients of attitudes towards mathematics and achievement in mathematics are used as measures of relationship. Therefore, there is not clear evidence in regard to whether attitude towards mathematics is a cause or an effect of achievement in mathematics (Neale, 1969; Enemark & Wise, 1981; Ethington & Wolfle, 1986; Quinn & Jadav, 1987).

12. There is a reciprocal or interactive nature between the attitudes towards mathematics and achievement in mathematics in order to modify their causal relationships. Therefore, there is a reciprocal relationship between the attitudes towards mathematics and achievement in mathematics (Marsh, 1986; Eccles, Meece & Wigfield, 1990; Tocci & Engelhard, 1991; Reynolds & Walberg, 1992; Ma, 1997; Abu-Hilal, 2000; Schreiber, 2002).

13. According to Briggs, Kolstad and Whalen (1996), mathematics became a less of a pure number exercise and more of a speaking, reading enterprise, which basically is the way practical mathematics is presented in everyday life. The mathematics curriculum includes the development of language and symbolism to communicate mathematical ideas and relationships (Grossman, Smith & Miller, 1993). Capps and Pickreign (1993) suggested that students must learn to communicate mathematically, in writing and through oral language. Therefore, a high correlation exists between the verbal achievement and the mathematics achievement indicators (Marsh, 1996).

These summary results suggest that there is a need for further studies in order to investigate the factors affecting mathematics literacy. The model examines the reciprocal relationship between the attitudes towards mathematics and mathematical literacy; the relationship between reading literacy and mathematical literacy; the relationship between mathematical literacy and attitudes towards reading, student-teacher relations, climate, communication with parents and usage of technology and facilities, and the relationship between reading literacy and attitudes towards reading, student-teacher relations, climate, communication with parents and usage of technology and facilities.

These findings indicate a general overview of the factors that are influential on mathematics achievement and correspondingly mathematical literacy. The PISA 2000 database is quite comprehensive to test different models across different cultural settings. The results might provide a general model that could be used by educators and policy makers to enhance student literacy experience across different cultural settings.

This study does not investigate the model proposed for the Turkish students, since the PISA 2003 data are not available at the moment. However, choosing three countries performing differently in PISA 2000 will provide a general overview of the proposed model in a cross-cultural fashion. Considering the similarities of some aspect of the education systems of the selected countries to the Turkish education system, there could be some inferences for the Turkish student at the same age level in the present study.

CHAPTER 3

METHODOLOGY

This chapter contains the methodology of the study, including Programme for International Assessment, population and sample, instruments, validity and reliability, procedure, data collection, data analyses and structural equation modeling. The population and sample selected and the instruments administered in PISA 2000 project were summarized in this section of the thesis. In addition, the processes acquired for the validity of the PISA 2000 project were also summarized in this section of the thesis.

3.1 Programme for International Student Assessment (PISA)

The OECD's Programme for International Student Assessment (PISA) is an international effort among the Member countries of the OECD. Its aim is to measure the 15-year-old young adults' performance. The assessment is different from the most of the international assessments with respect to its focus in the content. Most of the international assessments focus on the extent to which the students have mastered a specific curriculum. But in PISA, more importance is given to the ability to use knowledge and skills to meet the real life challenges. PISA concerns with what students can do with what they learn at school, not only with whether they have learned it. Therefore, there is a change in the goals and objectives of the curricula.

In PISA, student performance is assessed and data is collected on the student, family and institutional factors that can help to explain differences in performance. Decisions about the nature of the assessment and the background information to be collected were made by leading experts in participating countries and directed by their governments. To achieve cultural and linguistic breadth in the assessment, efforts and resources were devoted. In translation, sampling and data collection, quality assurance mechanisms were taken part. Consequently, the results of PISA have a high degree of validity and reliability.

PISA is a forward-looking assessment, based on a dynamic model of lifelong learning. In this model, new knowledge and skills are necessary for successful adaptation to a changing world. PISA assesses not only the students' knowledge, but also their ability to reflect on the knowledge and experience and to apply that knowledge and experience to real world issues. The term "literacy" is used to express this broader conception of knowledge and skills.

The first PISA survey was administered in 2000 in 32 countries including 28 OECD Member countries and 4 OECD Non-Member countries. PISA 2000 survey was about reading literacy, mathematical literacy and scientific literacy, with a focus on reading literacy. As a part of an international option, measures of attitudes to learning and information on how students manage their own learning were obtained in 25 countries. In 2002, another 13 countries were joined in order to complete the same assessment. Repeating the survey in every three-year-period was planned with the primary focus shifting to mathematical literacy in 2003, scientific literacy in 2006 and back to reading literacy in 2009. The participating countries are given in Table 3.1.

Table 3.1 Participating Countries in PISA

OECD countries participating in PISA 2000	Non-OECD countries participating in PISA 2000	Countries participating in PISA 2002	OECD countries participating in PISA 2003 onwards
Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States	Brazil, Latvia, Liechtenstein, Russian Federation	Albania, Argentina, Bulgaria, Chile, China, Special Administrative Region of Hong-Kong, Indonesia, Israel, Lithuania, Macedonia, Peru, Romania, Thailand	Slovak Republic, Turkey

The features in the development of PISA can be grouped:

1. The design and methods were determined by the need of governments to draw policies.
2. There is an innovative approach to literacy such as reading, mathematics and science.
3. A focus is given on the demonstration of knowledge and skills relevant to everyday life.
4. There is a geographical coverage which represents one third of the world population with the participation of 45 countries.
5. There is regularity with the decision of repeating the survey in every three-year-period.
6. Collaboration with the governments of the participating countries is formed.

3.2 Population and Sample

PISA needs to assess comparable target populations in order to achieve the comparability of the results. Differences between countries in nature and extent of pre-primary education and care, in the age of entry to formal schooling and in the structure of the education system do not allow school grades to be internationally comparable.

In order to provide the maximum coverage, the target population on the basis of the grade level is defined in some international assessments. The slight variation in the age distribution of the students across grade levels is a disadvantage of this grade-based target population. The variations in the distribution raise serious questions about the comparability of the results across the countries and within the countries. In addition, if the unrepresented students are enrolled in higher grade in one country and in lower grade in another country, this will exclude the students having higher levels of performance in the former country and the students having lower levels of performance in the latter country. Because of this, there may be serious bias in the results. As a consequence, PISA uses an age-based definition for its target population.

Students who are aged between 15 years 3 months and 16 years 2 months were covered in the assessment. The average age of the students was 15 years and 8 months across OECD countries. The grade or type of institution in which they are enrolled and of whether they are in full-time or part-time education was not regarded as a factor in the selection. Representing almost 17 million 15-year-old students enrolled in the schools of 32 participating countries were assessed in PISA 2000.

PISA excludes the 15-year-olds enrolled in Grade 6 or lower. In PISA 2000, such students only existed in significant numbers in Brazil. In addition, 15-year-olds not enrolled in educational institutions and residents attending schools in a foreign country were excluded from PISA.

Countries in PISA were permitted to exclude up a total of 5 per cent of the population with respect to the sampling standards used. The bias resulting from these exclusions of 5 per cent is likely to remain in one standard error of sampling.

Exclusions were done at the school level or at the student level. The limits of the exclusions at the school level:

1. Geographically inaccessible schools or the schools believed that administration of PISA assessment was not feasible were excluded.
2. Schools where teaching was provided only for students in categories, for instance, for the blinds were excluded.

The percentage of the students in such schools had to be less than 2.5 per cent of nationally desired target population.

The limits of the exclusions at the student level:

1. Educable mentally retarded students decided by the opinion of school principal or qualified staff members and the students unable to follow the instructions at the assessment were excluded.
2. Permanently or physically disabled students, but the functionally disabled students able to respond were included in the assessment were excluded.
3. Non-native language speakers attended less than one year of instruction in the language of the assessment were excluded.

Students could not be excluded because of normal discipline problems. The percentage of the students excluded within schools had to be less than 2.5 per cent of nationally desired target population.

At least 95 per cent of the target population was included in PISA 2000, except for Brazil, Luxembourg and Poland. Moreover, this ratio increased to more than 97 per cent in some countries. As a consequence of the maximum coverage of students, the comparability of the results is achieved. Therefore, some statements can be made about the knowledge and skills of individuals born in the same year and still at school at 15 years of age, but having different educational experiences. The PISA target populations and samples of the countries, Brazil, Japan and Norway, are given in Table 3.2.

Table 3.2 Target Populations and Samples in PISA

	Brazil	Japan	Norway
Total population of 15-years old	3 464 330	1 490 000	52 165
Total enrolled population of 15-years old	1 841 843	1 485 269	51 587
Total in national desired target population	1 837 236	1 459 296	51 474
School-level exclusions	6 633	34 124	420

Table 3.2 (Continued)

	Brazil	Japan	Norway
Total in national desired target population after school exclusions and before within-school exclusions	1 830 603	1 425 172	51 054
Percentage of school-level exclusions	0.36	2.34	0.82
Number of participating students	4 893	5 256	4 147
Weighted number of participating students	2 402 280	1 446 596	49 579
Number of excluded students	14	0	93
Weighted number of excluded students	7 842	0	944
Within-school exclusion rate (%)	0.33	0.00	1.87
Overall exclusion rate (%)	0.69	2.34	2.67
Coverage of national desired population	0.99	0.98	0.97
Coverage of national enrolled population	0.99	0.96	0.97

3.2.1 Sampling Procedures and Response Rates

Two-stage stratified sampling was used in most of the PISA samples. Firstly, individual schools where 15-year-old students were enrolled were selected. The selection of the schools was made systematically in the consideration of the probabilities proportional to size in order to include the estimated number of students. Although larger samples were required in national analyses, minimum 150 schools were selected in each country. After the schools were sampled, replacement schools were identified simultaneously. The identification of replacement schools was needed in case there was a problem in the participation of a sample school in PISA 2000. The sample selection process in each participating country was monitored by the experts from PISA Consortium.

Minimum participation rates for the schools and the students were required by the data quality standards in PISA in order to minimize the response biases. By meeting the standards, any bias resulting from non-response will be smaller than the sampling error.

For the initially selected schools, a minimum response rate of 85 per cent was required. When the initial response rate of schools was between 65 and 85 per cent, the required response rate was achieved by the usage of replacement schools. This procedure caused increased response biases. That’s why; the participating countries were encouraged to persuade the participating schools in the original sample. The schools where student participation rate was between 25 and 50 per cent were not regarded as participating schools. The data collected from such schools were included in the database and various estimations were applied. The data collected from schools where student participation rate was less than 25 per cent were excluded from the database.

A minimum participation rate of 80 per cent was required for the students within the participating schools. At the national level, not necessarily by each participating school, this minimum participation rate was required. If too few students participated in the original assessment sessions, make-up sessions were applied in the schools. Student participation rates were calculated over all participating schools. The calculation was made regardless of the original sample or replacement schools. The participation of students in not only the original assessment but also the make-up sessions was also not regarded in the calculation. In Table 3.3, the response rates in PISA among the countries, Brazil, Japan and Norway, are given.

Table 3.3 Response Rates in PISA

	Brazil	Japan	Norway
Weighted school participation rate before replacement (%)	97.38	82.05	85.95
Weighted number of responding schools before replacement	2 425 608	1 165 576	43 207
Weighted number of schools sampled before replacement	2 490 788	1 420 533	50 271
Weighted school participation rate after replacement (%)	97.96	90.05	92.25
Weighted number of responding schools after replacement	2 439 152	1 279 121	46 376
Weighted number of schools sampled after replacement	2 489 942	1 420 533	50 271
Weighted student participation rate after replacement (%)	87.15	96.34	89.28
Weighted number of students assessed	1 463 000	1 267 367	40 908
Weighted number of students sampled	1 678 789	1 315 462	45 821
Number of students assessed	4 885	5 256	4 147
Number of students sampled	5 613	5 450	4 665

3.2.2 Subjects of the Study

The present study is carried through the subjects of the participating countries, Brazil, Japan and Norway in PISA 2000. Therefore, the number of the subjects included in the study is given in the Table 3.4 on the basis of the participating countries.

Table 3.4 Distribution of the Number of Subjects with respect to Countries

	Brazil	Japan	Norway
Number of participating students	4 893	5 256	4 147
Number of students assessed	4 885	5 256	4 147
Number of students answered both the tests and the questionnaires used in the study	2 717	2 924	2 307
Number of students after the listwise deletion	1 682	2 476	1 770

In Table 3.5, the distribution of the gender of the students of the participating countries, Brazil, Japan and Norway is given. As can be seen, there were 851 female students and 831 male students in Brazil. In Japan, 1224 female students and 1252 male students were included. In Norway, there were 910 female students and 849 male students in the study. Since 11 students in Norway did not report their gender in the questionnaire, the gender of these 11 students could not be identified.

Table 3.5 Distribution of Gender of the Subjects

	Brazil	Japan	Norway
Female	851	1 224	910
Percent of Female (%)	50.6	49.4	51.4
Male	831	1 252	849
Percent of Male (%)	49.4	50.6	48.0
Missing	-	-	11
Percent of Missing (%)	-	-	0.6
Total	1 682	2 476	1 770

The distribution of the grades of the students in Brazil is given in Table 3.6. As can be seen from the Table 3.6, there was a wide range in the grades. There were 7th grade, 8th grade, 9th grade and 10th grade students in Brazil.

Table 3.6 Distribution of Grades of Subjects in Brazil

	Frequency of the Students	Percentage (%)
7th Grade	322	19.1
8th Grade	530	31.5
9th Grade	685	40.7
10th Grade	145	8.6
Missing	-	-
Total	1 682	100.0

The distribution of the grades of the students in Japan is given in Table 3.7. Obviously from the Table 3.7, all the students in Japan were 10th grade students.

Table 3.7 Distribution of Grades of Subjects in Japan

	Frequency of the Students	Percentage (%)
10th Grade	2 476	100.0
Missing	-	-
Total	2 476	100.0

The distribution of the grades of the students in Norway is given in Table 3.8. The grades ranged from 9th grade to 11th grade, but almost all students were in 10th grade, as can be seen from the Table 3.8. In Norway, 5 students did not report their grades in the questionnaire. Therefore, the grades of these 5 students could not be identified.

Table 3.8 Distribution of Grades of Subjects in Norway

	Frequency of the Students	Percentage (%)
9th Grade	8	0.5
10th Grade	1 752	99.0
11th Grade	5	0.3
Missing	5	0.3
Total	1 770	100.0

The distribution of the birth year of the students on the basis of the participating countries is given in Table 3.9. In Brazil, % 46.5 of the students were born in 1984 and % 53.5 of the students in 1985. In Japan, 1984 was the birth year of % 76.3 of the students and 1985 was the birth year of % 23.7 of the students. Lastly in Norway, almost all the students, % 99.8 of the students was born in 1984. There was no information about the birth year of the % 0.2 of the students, since these 4 students did not report their birth year in the questionnaire.

Table 3.9 Distributions of Birth Years of the Subjects among Countries

	Brazil	Japan	Norway
1984	782	1 888	1 766
Percentage (%)	46.5	76.3	99.8
1985	900	588	-
Percentage (%)	53.5	23.7	-
Missing	-	-	4
Percentage (%)	-	-	0.2
Total	1 682	2 476	1 770

3.3 Instruments

The three domains were examined in PISA 2000. These three literacy domains were reading, mathematical and scientific literacies. But, only two domains, reading and mathematical literacies were included in this study. The concept of literacy used in PISA has a meaning more than the ability to read and write. Literacy is continuous which is not something either to have or not have. Between a fully literate person and an individual that is not literate, there is not a clear dividing line.

The literacy takes place not only at school or through formal learning, but also through interactions with peers, colleagues and wider communities. That's why, literacy is a lifelong process. Although the 15-year-old students cannot be expected to know everything as adults, they should have the knowledge and skills in areas such as reading, mathematics and science. In addition, to apply their learning to the real world, they should know some elementary processes and principles. Because of this, the ability to complete tasks related with real life is assessed in PISA.

In addition to literacies in reading and mathematics domains, competencies across disciplinary boundaries were assessed in PISA. These were student motivation, aspects of students' attitudes towards learning, familiarity with computers and aspects of students' strategies for managing and monitoring their own learning. Moreover, problem solving and skills in information technologies were examined under the heading cross-curricular competencies.

PISA aims to succeed in measuring skills for life. If the people having high levels of skills, which are measured in PISA, are likely to succeed in life, it gives an evidence for the goal of PISA. This cannot be a strict decision whether the goal is achieved or not because the future outcomes for the students cannot yet be known. But according to the International Literacy Survey (IALS), adults' reading and mathematical literacy skills are closely related with their success and earnings.

The domains covered in PISA are as follows (OECD Publications, Knowledge and Skills for Life, 2001):

1. The content or structure of knowledge

The students were encouraged to acquire this knowledge in each domain, for instance, familiarity with various text types.

2. The processes

The students were directed to perform these processes, for instance, retrieving written information from a text.

3. The contexts

The students were encouraged to apply their knowledge and skills in these contexts, for instance, making decisions in relation to one's personal life.

More emphasis was given to the reading literacy in PISA in which literacies in three domains such as reading, mathematics and science were measured. Because two-thirds of the assessment time was spent on reading literacy. Mathematical literacy is emphasized in PISA 2003 and scientific literacy will be looked closely in PISA 2006.

The factors affecting mathematical literacy are examined in this thesis, as said before. In addition to mathematical literacy, reading literacy is included in the model so as to fin out the factors affecting reading literacy as well. The reason for this inclusion of reading literacy is the importance of language in student performance on assessments in content-based areas such as mathematics. Therefore, in this study, data of PISA 2000 Mathematical Literacy Assessment, Reading Literacy Assessment, PISA 2000 Student Questionnaire and PISA 2000 Cross-Curricular Competencies Questionnaire were used.

3.3.1 Reading Literacy Assessment

Reading literacy in PISA was defined in Knowledge and Skills for Life (OECD Publications, 2001) as follows:

> Reading Literacy is the ability to understand, use and reflect on written texts in order to achieve one’s goals, to develop one’s knowledge and potential, and to participate effectively in society. This definition goes beyond the notion that reading literacy means decoding written material and literal comprehension. Reading incorporates understanding and reflecting on texts. Literacy involves the ability of individuals to use written information to fulfill their goals, and the consequent ability of complex modern societies to use written information to function effectively (p.21).

There were 140 items representing reading literacy. In these items, there was a given text in a variety of ways. In this process, there were many dimensions, three of which were used in PISA assessments.

1. The form of reading material

Prose given in sentences, paragraphs or continuous text was focused in many past assessments. But in PISA, continuous prose passages and types of prose like narration, argumentation and exposition took place in reading material. Moreover, non-continuous texts such as graphs, diagrams, lists and forms were also included. Because, in real life, individuals use both the written texts and different information-processing techniques to get information.

2. The type of reading task

PISA focused on the concept that individuals should read to learn something, not learn to read something. It was believed that the students had already acquired the reading skills in the reading literacy items. According to the Knowledge and Skills for Life, the students were expected to achieve the followings in reading literacy:

2.1 retrieving information

2.2 understanding texts at a general level

2.3 interpreting

2.4 reflecting on the content and form of texts in relation with their own knowledge of the world

2.5 evaluating

2.6 arguing their own point of view

3. The use for which the text was constructed

The use for which the text was constructed depended on its context or situation. For instance, a textbook or worksheet might be educational use and a manual or report might be occupational use.

In reading literacy assessment, students were asked a number of tasks on each text. Students were wanted to construct their own responses in 45 per cent of the tasks. In these open-ended questions, students could provide a brief answer or construct a longer response. The aim in open-ended questions was relating the information given in the text to their own opinions and experiences. All the answers to these questions were marked by hand. Partial credit was given to the answers partially correct or less sophisticated. The other 45 per cent of the items were in multiple-choice format. The students answered these multiple-choice questions by either selecting one choice from four or five alternatives or making a choice from the given words or phrases. The students were required to construct their own responses from a limited range of acceptable answers in the remaining 10 per cent of the tasks. The distribution of the reading items by text type and by item type was shown in Table 3.10.

Table 3.10 Distribution of Reading Items by Text Type and by Item Type

Text Type	Number of Items	Multiple-Choice	Constructed Response	Short Response
Advertisements	4(3)	-	1	3(3)
Argumentative/Persuasive	18(1)	8	10(1)	-
Charts/Graphs	16(1)	8(1)	5	3
Descriptive	13(1)	8	4(1)	1
Expository	31	18	9	4
Forms	8	2	5	1
Injunctive	9	3	6	-
Maps	4	1	1	2
Narrative	18	8	8	2
Schematics	5	4	-	1
Tables	15(3)	3(2)	9(1)	3
Total	141(9)	63(3)	58(3)	20(3)

Note: The numbers in parenthesis indicate the number of items deleted after the main study analysis.

3.3.2 Mathematical Literacy Assessment

Mathematical literacy in PISA was defined in Knowledge and Skills for Life (OECD Publications, 2001) as the following:

> Mathematical Literacy is the capacity to identify, understand and engage in mathematics, and to make well-founded judgments about the role that mathematics plays in individuals' current and future private life, occupational life, social life with peers and relatives, and life as a constructive, concerned and reflective citizen. The definition revolves around the wider uses of mathematics in people's lives rather than being limited to mechanical operations. Mathematical literacy is the ability to put mathematical knowledge and skills to functional use rather than just mastering them within a school curriculum (p.22).

The study covered, for instance, not only deciding how much a change to give someone in a shop, but also having an opinion about a government's spending plans. The ability to pose and solve mathematical problems in a variety of situations was indicated in mathematical literacy. Obviously, self-confidence and curiosity were required for this ability.

In the mathematical literacy assessment, three dimensions were used:

1. The content of mathematics

The relevant, connected mathematical concepts related with real situations and contexts took part in the content of mathematics. The included concepts were quantity, space and shape, change and relationships and uncertainty. This did not mean that the subjects of mathematics like numbers, algebra and geometry were excluded. Since a focus was given to reading literacy assessment, mathematical literacy assessment was limited. This limitation gave an emphasis on change and relationships and space and shape although the concepts were selected in order to represent the mathematics curriculum as possible.

2. The process of mathematics

Different types of mathematical skills were included in mathematical literacy questions. Competency clusters were formed based on the types of mathematical skills. According to Knowledge and Skills for Life, these competency clusters were grouped as:

2.1 reproductions in which simple computations and definitions of the type most familiar in conventional assessments of mathematics

2.2 connections which required the bringing together of mathematical ideas and procedures to solve straight forward and somewhat familiar problems

2.3 reflections which consisted of mathematical thinking, generalization and insight and required students to engage in analysis, to identify the mathematical elements in a situation and to pose their own problems

3. The situations in which mathematics was used

Mathematical literacy questions were based on situations which represent the kinds of problems faced with in real life. The situations were grouped according to the closeness to the student such as private or personal life, school life, work and sports, local community and society and scientific.

In mathematical literacy assessment, a combination of question types was used. A problem or situation was represented on each task and a set of questions was asked depending on the problem or situation. The questions were grouped as units according to the context. On each unit, diagrams and written information were given with a range of questions. The two-thirds of mathematics tasks were asked in a form that the answers could be marked as correct or incorrect unambiguously. Students were required to show their proficiency about the mathematical principles involved in the task in such questions. The other one-third of the tasks was more complex items. Therefore, full credit or partial credit was given to the answers of these questions. The distribution of mathematics items by mathematical content strands and by item type was shown in Table 3.11.

Table 3.11 Distribution of Mathematics Items by Mathematical Content Strands and by Item Type

Mathematical Content Strands	Number of Items	Multiple-Choice	Closed Constructed -Response	Open Constructed -Response
Algebra	5	-	4	1
Functions	5	4	-	1
Geometry	8	3	5	-
Measurement	7(1)	3(1)	4	-
Number	1	-	1	-
Statistics	6	1	4	1
Total	32(1)	11(1)	18	3

Note: The numbers in parenthesis indicate the number of items deleted after the main study analysis.

Valuable information about the students' ideas and thinking could be provided from the students' responses, either correct or incorrect. The marking guides for mathematics included a system of two-digit coding for marking. Therefore, the frequency of various kinds of correct and incorrect responses could be recorded. The first digit was the actual score, whereas the second digit was used to categorize the different types of responses. The categorization was based on the strategies used by the student to answer the item. The usage of double-digit coding has two main advantages. Firstly, more information can be collected about students' misconceptions, common errors and different approaches in solving problems. Secondly, a more structured way of presenting the codes, indicating the hierarchical levels of groups of codes, is allowed by double-digit coding (OECD Publications, 2002).

Table 3.12 Inter-Rater Summary by Country

Country	Frequency	Percentage Consistent	Percentage Inconsistent	Percentage Harsh	Percentage Lenient
Brazil	1 248	91,5	4,6	0,6	3,4
Japan	1 248	95,0	1,8	0,7	2,5
Norway	1 248	92,9	4,4	0,6	2,1

As can be seen from Table 3.12, a high percentage of consistent agreements were observed for each of the countries included in this study. The international verifier or the adjudicator agreed with the national marks in more than 90 per cent of cases, when investigated from the Table 3.12.

In PISA 2000, not all of the students responded to all of the mathematics and reading items. Therefore, student proficiencies or measures were not observed. Since there were missing data that could be inferred from the observed item responses, several possible alternative approaches could be applied for making this inference. PISA used two approaches such as maximum likelihood using Warm's (1985) Weighted Likelihood Estimator (WLE) and maximum likelihood using plausible values (PVs). Plausible values are a selection of likely proficiencies for students that attained each score. The plausible values are not text scores and should not be treated as such. They are random numbers drawn from the distribution of scores that could be reasonably assigned to each individual (Adams, 2002). Therefore in this study, five overall mathematics literacy plausible values from PV1MATH to PV5MATH and five combined reading literacy plausible values from PV1READ to PV5READ were used. These plausible values were observed variables to represent the mathematical literacy and reading literacy latent variables. Because of the high standards for quality of the PISA 2000 design, test instruments were assumed to be highly valid and reliable.

3.3.3 Student Questionnaire

Each student in the Programme for International Assessment was asked to complete a student questionnaire. The statements in the student questionnaire were prepared in order to get information about the students. The basic demographics such as date of birth, grade at school, gender, family structure, number of siblings and birth order were included in the questionnaire. Besides, information about family background and measures of socio-economic status; student description of school or instructional processes; student attitudes towards reading and reading habits; student access to educational resources outside school; institutional patterns of participation and programme orientation and student career and educational expectations was collected. From this questionnaire, 25 items were included in this study. The selection of questions was based on the willingness of investigating the effects of these determined variables. In addition, the percentage of missing data of the variables was essential factor in the selection of the variables. The selected items are given below:

Q19. In general, how often do your parents:

a) discuss books, films or television programmes with you?
b) discuss how well you are doing at school?
c) eat the main meal with you around a table?
d) spend time just talking to you?

The items 19a, 19b, 19c and 19d were scaled on a five-point likert type scale such as Never or hardly ever, A few times a year, About once a month, Several times a month and Several times a week. The items were coded as 1 if the student selects never or hardly ever for the asked frequency of the statement and 5 if the student selects several times a week for the asked frequency of the statement in the item.

Q26. How often do these things happen in your test language lessons?

a) The teacher has to wait a long time for students to quieten down.
b) Students cannot work well.
c) Students don’t listen to what the teacher says.
d) Students don’t start working for a longtime after the lesson begins.
e) There is noise and disorder.
f) At the start of class, more than five minutes are spent doing nothing.

The items 26a, 26b, 26c, 26d, 26e and 26f were scaled on a four-point likert type scale such as Never, Some lessons, Most lessons and Every lesson. The items were coded as 1 if the student selects never for the asked frequency of the statement and 4 if the student selects every lesson for the asked frequency of the statement in the item. As can be seen from the content of the questions in this item, recoding of the data was needed in the analyses. However, the data were not recoded because the recoding of the data was done at the data cleaning process by the Consortium.

Q30. How much do you disagree or agree with each of the following statements about teachers at your school?

a) Students get along well with most teachers.
b) Most teachers are interested in students' well being.
c) Most of the teachers really listen to what I have to say.
d) If I need extra help, I will receive it from my teachers.
e) Most of my teachers treat me fairly.

The items 30a, 30b, 30c, 30d and 30e were scaled on a four-point likert type scale such as Strongly Disagree, Disagree, Agree and Strongly Agree. The items were coded as 1 if the student strongly disagrees the statement given and 4 if the student strongly agrees the statement given in the item.

Q35. How much do you disagree and agree with these statements about reading?

a) I read only if I have to.
b) Reading is one of my favourite hobbies.
c) I like talking about books with other people.
d) I feel happy if I receive a book as a present.
e) For me, reading is a waste of time.
f) I enjoy going to a bookstore or a library.
g) I cannot sit still and read for more than a few minutes.

The items 35a, 35b, 35c, 35d, 35e, 35f and 35g were scaled on a four-point likert type scale such as Strongly Disagree, Disagree, Agree and Strongly Agree. The items were coded as 1 if the student strongly disagrees the statement given and 4 if the student strongly agrees the statement given in the item. As can be seen from the content of the questions 35a, 35e and 35g, recoding of the data was needed in the analyses. However, the data were not recoded because the recoding of the data was done at the data cleaning process by the Consortium.

Q39. At your school, about how often do you use:

a) school library?
b) computers?
c) calculators?

The items 39a, 39b and 39c were scaled on a five-point likert type scale such as Never or hardly ever, A few times a year, About once a month, Several times a month and Several times a week. The items were coded as 1 if the student selects never or hardly ever for the asked frequency of the statement and 5 if the student selects several times a week for the asked frequency of the statement in the item.

3.3.4 Cross-Curricular Competencies Questionnaire

The cross-curricular competencies questionnaire was an optional questionnaire, which was administered in 26 out of 32 countries. The questionnaire was based on self-report on self-regulated learning. The questionnaire sought information about the strategies of self-regulated learning, motivational preferences for different types of learning situations. From this questionnaire, 6 items representing the attitude of the students towards mathematics were selected in this study. The selection of these questions was based on the relevance of the statements to the learning of mathematics. Since the questionnaire was an optional questionnaire, it was not administered in Japan which is included in this study. Therefore, since the students in Japan did not report their ideas to these statements in the questionnaire, the information about the content of these statements was not collected. The selected items from this questionnaire were as follows:

Q2. How much do you disagree or agree with each of the following?

a) I learn most when I work with other students.
b) Because doing mathematics is fun, I wouldn't want to give it up.
c) I get good marks in mathematics.
d) Mathematics is one of my best subjects.
e) I have always done well in mathematics.
f) Mathematics is important to me personally.

The items 02a, 02b, 02c, 02d, 02e and 02f were scaled on a four-point likert type scale such as Disagree, Disagree Somewhat, Agree Somewhat and Agree. The items were coded as 1 if the student disagrees the statement given and 4 if the student agrees the statement given in the item.

3.4 Validity and Reliability

3.4.1 Content-Related Evidence for Validity

Since an international study is among a wide range of cultures and languages, test development process was acquired by the cooperation between the Consortium and the participating countries. A guideline was prepared explaining the purpose of the project and the characteristics of the text types, formats and response formats in order to obtain information to the participating countries. The items were written on the consideration of the guideline and then submitted to the Consortium or the Functional Expert Group (FEG). The Consortium reviewed the items. The developed assessment items were reviewed by the subject-matter specialists and assessment experts, on the basis of the internationally agreed assessment frameworks and test specifications. The item review process included paneling by the test development team, national reviews in each country, reviews by the Functional Expert Group (FEG), pre-pilots in Australian and Dutch schools and close examination by the team of translators. In order to ensure the adequate coverage of the areas, additional items were developed. Firstly, pilot study was conducted and then the results were reviewed. Finally, the participating countries rated the items in accordance with the cultural appropriateness, curricular and non-curricular relevance and appropriateness of the difficulty level. Therefore, the validity of the items across countries was acquired.

There are translation procedures in order to acquire the equivalence of the national test and questionnaire materials. A back translation procedure refers translating the source version of the test into the national languages, and then translating them back to the source language. The two source language versions of the test are compared in order to identify possible discrepancies. On the other hand, a double translation procedure includes two independent translations from the source language, and reconciliation by a third person. By this translation, equivalence of the source and target languages is acquired by using three different people who are the two translators and a reconciler. In addition, the discrepancies are recorded in the target language instead of in the source language. Although the back translation procedure was used in the earlier studies by the International Association for the Evaluation of Educational Achievement (IEA), a double translation procedure was used in Third International Mathematics and Science Study Repeat (TIMSS-R). Since both the back translation and the double translation procedures fall short in the equivalence of the various national versions, the double translation procedure from two different languages was used in PISA. When a single source language is used, it has more impact than desirable on the target language versions due to the characteristics of the source language. By using the double translation procedure, the equivalence between the source and target versions was performed by four different people, two translators, one national reconciler and the Consortium's verifier. Benchmarks for a national reconciler were provided by the two source versions in different languages. When any translation problem was appeared because of the structures of that language, the version of the other language could be used. Lastly, the impact of cultural characteristics of a single source language was smaller with the two different language versions.

Although each student was assessed for two hours, all of the students did not answer the same assessment items. In order to contain all the areas, a range of items equivalent to seven hours of assessment time were selected. From these items, different combinations of items were formed and grouped into nine different booklets. Each item was contained in several booklets in order to have a representative sample of students fro the items. However, each student answered one booklet. The domains, which were included in the booklets, were shown in Table 3.13.

Table 3.13 The Booklets and the Including Domains in the Booklets

Booklets	Content
Booklets 8 and 9	Reading, Mathematics and Science Questions
Booklets 1, 3 and 5	Reading and Mathematics Questions
Booklets 2, 4 and 6	Reading and Science Questions
Booklet 7	Only Reading Questions
Booklet 0	Reading, Mathematics and Science Questions

As can be seen from the Table 3.13, there was an additional booklet referred as booklet 0. This booklet was called Special Education (SE). It was prepared to assess students attending special schools. The aim for the preparation of SE was to include 15-year-old students in each country as many as possible. The questions in SE had a lower difficulty level than the questions in the other booklets. This booklet was administered in a limited number of countries in which the proportion of 15-year-old students in special schools was high. All the students in these schools were covered in the sample. Table 3.14 shows the total number of sampled students, broken down by participating country and test booklets (Adams & Carstensen, 2002)

Table 3.14 Number of Sampled Students by Country and Booklet

		Country	
Booklet	Brazil	Japan	Norway
SE	-	-	-
1	545	585	459
2	547	582	471
3	545	586	465
4	539	584	458
5	556	590	465
6	553	585	461
7	537	581	450

Table 3.14 (Continued)

	Country		
Booklet	Brazil	Japan	Norway
8	532	578	461
9	539	585	457
Total	4 893	5 256	4 147

3.4.2 Construct-Related Evidence for Validity

A factor analysis was conducted in order to reduce the number of the observed variables by grouping those in factors. The factors of the interest were selected and then included in the model as latent variables. The latent variables were named by the investigation of the content of the observed variables. Since a model testing was conducted in this study, there was not a chance to include all the observed variables in the selected latent variables. If all the observed variables were included, the model testing would be very complex and confusing. The observed variables in latent variables were selected on the basis of the factor analysis. The observed variables with high factor loadings in the factor analysis were included in the latent variables. The observed variables contained in latent variables and their factor loadings in the factor analysis can be found in the next chapter.

3.4.3 Reliability

The reliability analysis was conducted separately for each latent variable through each country in order to obtain the internal-consistency estimates of reliability. The alpha reliability coefficients of the latent independent variables and the alpha reliability coefficients of the Mathematics Scale and Reading Scale were separately calculated through each country by conducting a reliability analysis, respectively. The alpha reliability coefficients of the observed variables, the latent variables including observed variables, and the mathematics and reading scales for each country are presented in results section of the thesis.

At the international level, the reliability of the PISA Reading Scale and Mathematics Scale were 0.93 and 0.90, respectively. The reliability values 0.90 for Mathematics Scale and 0.93 for Reading Scale are quite high values representing high reliability (Adams & Wu, 2002).

3.5 Procedure

In the period between February 2002 and September 2002, extensive and detailed information was obtained about the Structural Equation Modeling (SEM), such as theory and development and the assessment of the model fit. In order to get information about the structural equation modeling, several books were searched and computer search was conducted. Besides the structural equation modeling, general information was obtained about the international assessments, the purposes of these international projects and their international reports.

Between the period September 2002 and December 2002, detailed information was obtained about the Programme for International Student Assessment (PISA), test design and test development, student questionnaire development, sample design, translation and cultural appropriateness of the test and survey materials, field operations, quality monitoring, scaling data, data cleaning procedures and database files of PISA 2000 by the help of the publications and supporting documents (Technical Report of PISA 2000, Knowledge and Skills for Life-First Results of PISA 2000, Manual for the PISA 2000). In addition, a computer search (PISA Web Site-www.pisa.oecd.org) was conducted about the related documents of PISA 2000.

In the year 2003, the three participating countries in PISA 2000 were determined in accordance with the location in the increasing order of the mathematical literacy, one from top; Japan, one from middle; Norway and one from bottom; Brazil. The results of the selected countries would be modeled through the model testing in this study. Many factor analyses were conducted with the items of questionnaires included in PISA 2000 in order to investigate the constructs of the questionnaires. The factor analyses were generally based on Brazil data. Then the items and the related factors were selected on the basis of the interest of investigation, related literature and the results of the obtained statistics. After the problems and related keywords were decided, a detailed computer search was conducted for the literature review. Moreover, Hacettepe Üniversitesi Eğitim Fakültesi Dergisi and Eğitim ve Bilim Dergisi were searched by hand. Lastly, the actual models were tested and the modifications of the models were done separately for each country.

3.6 Data Collection

International network of leading institutions and experts took place in the design of PISA 2000. The PISA 2000 assessments were in printed form. The students were asked to answer the questions in the consideration of the written passages and diagrams. Its aim was to find out whether the students could think actively or not. Each 15-year-old student was given a written assessment of two hours in his/her own school. In addition, responding to a questionnaire about himself/herself took about half an hour for every student. The same principles were followed in each of the three domains and from one survey to the next.

The implementation was acquired through the procedures prepared by the Consortium in each country by a National Project Manager (NPM). Besides National Project Manager (NPM), the School Coordinators and Test Administrators also took place in the implementation of the assessment. Each National Project Manager (NPM) had a base location like national center in the implementation. National Project Managers (NPMs) were responsible for the implementation of the project within their own country. The school-related activities were coordinated by the School Coordinators (SCs) with the National Project Managers (NPMs) and Test Administrators. Lastly, the Test Administrators (TAs) were responsible for the administration of the PISA test in accordance with the international standards and PISA procedures (Caldwell & Lokan, 2002).

Comprehensive procedural manuals for each major component of the assessment were given to National Project Managers (NPMs). The National Project Manager's Manual provided detailed information about the duties and responsibilities. It included general information about PISA; field operations; roles and responsibilities of the NPM, the SC and the TA; translating the manuals and test instruments; selecting the sample; assembling and shipping materials; data marking and entry; and documentation to be submitted by the NPM to the Consortium. The

School Coordinator's Manual described the activities and responsibilities of the SC. It provided information about all aspects, from selecting a date for the assessment to arranging for a make-up session and storing the copies of the assessment forms. The Test Administrator's Manual included a comprehensive description of the duties and responsibilities of the TA, from attending the TA training to conducting a make-up session. In addition, it provided the script to be read during the test as well as the Return Shipment Form, which was a form designed to track materials to and from the school. And lastly, the Sampling Manual included detailed instructions about the selection of the school and student samples and the reports that had to be submitted to the Consortium so as to document each step in the process of selecting these samples. Checklists and timetables for easy reference were also contained in all these manuals (Caldwell & Lokan, 2002).

Since the marking of the students' responses is very important for the comparability of the results in the study, a guide named Marking Guides was prepared by the Consortium. The guide included comprehensive criteria for marking, such as many examples of acceptable and not acceptable responses. The Marking Guides for each of reading and mathematics were provided to NPMs by the Consortium. The NPMs were responsible for selecting appropriately qualified people to acquire the single and multiple marking processes of the test booklets (Caldwell & Lokan, 2002).

The data entry was done through the data entry software KeyQuest. The data were entered directly from the test booklets and the questionnaires, except for the multiple-marking study. Because the marks from the first three markers had been written on separate sheets in the multiple-marking study. Validation checks were performed as the data were entered by the KeyQuest software. A manual called Data Entry Manual is provided. The manual included the full details of the functionality of KeyQuest software and complete instructions on data entry, data management and the way to carry out validity checks. NPMs were responsible for the ensurance of many checks of the quality of their country's data before the data files were submitted to the Consortium (Caldwell & Lokan, 2002).

PISA 2000 Quality Control and Assurance Program took place in the data cleaning process. The data cleaning and analysis phases contained detection of all anormalities and inconsistencies in submitted data and not having errors. In order to reach these high quality requirements, dual independent processing was implemented by the Consortium. The data cleaning procedures were carried out independently by two data analysts. The procedures were considered as complete only when identical results and files were produced by the two PISA databases received from countries. Specific data cleaning or recoding procedures or at least adaptation of standard data cleaning procedures were needed in data files that were submitted by national centers. Therefore, two analysts independently cleaned all submitted data files. The cleaning and analysis procedures were run with both SAS and SPSS softwares. As a result, the national databases were produced by three teams of data analysts. A team leader was included in each team who was the only person to communicate with national centers (Monseur, 2002).

Necessary data files used in this study were downloaded from the PISA International database included in the PISA web Site, www.pisa.oecd.org. All the information about the structure of the data files was obtained from the codebook files contained in PISA Web Site and the book named “Manual for the PISA 2000 Database”.

3.7 Data Analyses

All the variables in the PISA 2000 Student Questionnaire and PISA 2000 Cross-Curricular Competencies Questionnaire data files were examined. The variables of the interest of investigation were selected from these data files. The variables filled in a bad manner that too many missing data included and the unnecessary variables were deleted from the used database of this study.

3.7.1 Missing Data Analyses

The missing percentage of the questionnaire items was an essential factor in the defining the items that would be contained and analyzed. In order to find out the missing percentages, the items in the questionnaires were analyzed separately for each of the three countries included in this study.

The criterion of the missing percentage was 10%, in general. In Brazil, the missing values ranged from 3.7% to 9.8%. The item, teachers wait long time had the missing value 3.7%, whereas the items, how often use calculators and math absorbed had the missing value 9.8%. Most of the missing values were under 10%. However, there were exceptions in the Brazil data with the values; How often use computers 10.4%, Done well 12.8%, Good marks Math 11.0%, Math best 12.3%, Math fun 10.7% and Math important 12.7%.

In Japan, all of the missing values were under 10% ranging from 2.8% to 5.3%. The item, few minutes only had the missing value 2.8%, whereas the item, Students don't start had the missing value 5.3%. The items from the cross-curricular competencies questionnaire were not included in this study since the students in Japan did not report their ideas about the items asked in this questionnaire. All the items of this questionnaire were entered as missing values in the database since this questionnaire was an optional one.

In Norway, all of the missing values were under 10%. The missing values were ranged from 1.6% to 7.1%. The items, teachers wait long time and eat main meal had the missing values 1.6%, whereas the item, math important had the missing value 7.1%.

In the conduction of factor analyses, listwise deletion method was used. In order not to have ambiguous or wrong results in the factor analyses indicating incorrect group of variables in the factors, the listwise deletion method was preferred in the handling of the missing data. Furthermore, the listwise deletion method was also used in the model testing. So as to handle the missing data in the model testing, the listwise deletion method was chosen, as well. The chance to obtain meaningless or senseless results was avoided by the usage of the listwise deletion method.

3.7.2 Effect Sizes

The effect size can be defined as the magnitude of an independent variable's effect, usually expressed as a proportion of explained variance in the dependent variables (Weinfurt, 1995).

A multiple correlation (R), a squared multiple correlation (R^2) and an adjusted squared multiple correlation (R^2_{adj}) are the multiple correlation indices. These indices assess how well the linear combination of predictor variables in the regression analysis predicts the criterion variable. The multiple correlation is a Pearson product-moment correlation coefficient between the predicted criterion scores and the actual criterion scores. The multiple correlation (R) ranges in value from 0 to 1. A value of 0 indicates that there is no linear relationship between the predicted scores and the criterion scores. A value of 1 implies that the linear combination of the predictor variables perfectly predicts the criterion variable. Values between 0 and 1 means a less than perfect linear relationship between the predicted and criterion scores. In order to interpret the values of R between 0 and 1, R may be squared and multiplied by 100 to make a percent of variance accounted for interpretation. The adjusted multiple correlation (R^2_{adj}) can be calculated when the sample size is small and the number of predictors is large. Because, the squared multiple correlation (R^2) shows greater bias in such samples (Green, Salkind and Akey, 1997).

The measure of effect size is roughly equivalent to the R^2 used in multiple regression. The classification of effect sizes of Cohen (1977) has become somewhat of a standard in social research. The proper standard classification scheme should be the one Cohen suggested for effect sizes measured in terms of R^2. The classification scheme indicates such indices for effect sizes: 0.01 is small, 0.09 is medium and 0.25 or greater is large. The social studies generally produce small to medium effect sizes (Weinfurt, 1995).

The effect sizes in measures of squared multiple correlation (R^2) through each country's models were given in Table 3.15.

Table 3.15 The Effect Sizes of the Models of Each Country in R^2

Country	Latent Variables	Squared Multiple Correlation (R^2)
BRAZIL	ATTMATH	0.08
	READLIT	0.17
	MATHLIT	0.78
JAPAN	READLIT	0.21
	MATHLIT	0.73

Table 3.15 (Continued)

Country	Latent Variables	Squared Multiple Correlation (R^2)
NORWAY	ATTMATH	0.26
	READLIT	0.20
	MATHLIT	0.76

Since the indices for effect sizes are 0.01 for small, 0.09 for medium and 0.25 or greater for large, the effect sizes were interpreted easily from the Table 3.15.

In Brazil, the attitudes towards mathematics had an effect size value 0.08 which could be indicated as medium because of the nearness to the medium index 0.09; the reading literacy had an effect size of 0.17 which could be indicated as large because of the nearness to the large index 0.25; and the mathematical literacy had an effect size value 0.78 which was large. In addition, the included variables explained 8% of the variance of attitude towards mathematics; 17% of the variance of the reading literacy and 78% of the variance of mathematical literacy.

In Japan, the effect size of the attitudes towards mathematics could not be calculated since the latent variable named the attitude towards mathematics was not included in the model as latent dependent variable. Moreover, this latent variable was not contained as a latent variable either because the questionnaire including the items of this latent variable was not administered in the assessment in Japan. The reading literacy had an effect size of 0.21 which could be indicated as large due to the nearness to large index 0.25; and the mathematical literacy had an effect size value 0.73 which was large. Furthermore, the included variables explained 21% of the variance of the reading literacy and 73% of the variance of mathematical literacy.

In Norway, the attitudes towards mathematics had an effect size value 0.26 which was large; the reading literacy had an effect size of 0.20 which could be indicated as large due to the nearness to large index 0.25; and the mathematical literacy had an effect size value 0.76 which was large. Moreover, the included variables explained 26% of the variance of attitude towards mathematics; 20% of the variance of the reading literacy and 76% of the variance of mathematical literacy.

3.7.3 Data Analyses

Firstly, the data of the each included country in this study was examined. After the examination of the variables of the included countries, Varimax Rotated Principle Components Factor Analyses were run for each questionnaire contained and for each included country's data by using SPSS 11.0 for Windows in order to explore the factor structures of the items in the questionnaires. The observed variables with high factor loadings were selected as latent variables on the basis of the results of the Brazil factor analyses. The final data files of each country including the items that would be contained in the model testing were imported from SPSS 11.0 for Windows to PRELIS 2.30 for Windows. Moreover, reliability analyses for each country were conducted using SPSS 11.0 for Windows. The Cronbach's-α reliability coefficients of latent variables included were calculated using the data of each country separately.

After the final data files were imported to PRELIS 2.30 for Windows, the data screening was conducted in order to obtain the distributions of the variables and to check the normality of the variables. Later on, the program was run so as to supply the needed steps before model testing. Finally, LISREL 8.30 for Windows (Linear Structural Relations statistics package program) with SIMPLIS command language was used for the formulation and estimation of the LISREL models including the factors affecting mathematical literacy of 15-year-old students participated in PISA 2000 in Brazil, Japan and Norway.

3.8 Structural Equation Modeling

In order to clarify the terms and to avoid possible semantic difficulties, the definitions of the terms used in this study are explained.

3.8.1 Definition of Terms

1. Path Diagrams

A path diagram is a diagram that gives the structural relations forming the model. The variables are linked by arrows in the path diagram. The unidirectional arrows represent the causal relations and the bi-directional curved arrows represent the noncausal or correlational relationships (Kelloway, 1998).

2. Observed, indicator or manifest Variables

Observed variables are the directly observable or measured variables (Schumacker & Lomax, 1996).

3. Latent or unobserved Variables

Latent variables are indirectly observable or measured variables. They are the variables that are not observed or measured directly. Latent variables can be indirectly measured through observable variables (Schumacker & Lomax, 1996).

4. Latent Dependent Variables

Latent dependent variable is the latent variable which is influenced by some other latent variable in the model. The latent dependent variables are measured on the basis of the observed dependent variables (Schumacker & Lomax, 1996).

5. Latent Independent Variables

Latent independent variable is the latent variable which is not influenced by any other latent variable in the model. The latent independent variables are measured on the basis of the observed independent variables (Schumacker & Lomax, 1996).

6. Structural Equation Models

The path models in which the factors are viewed as latent variables are often used in order to diagram the structural equation models (Jöreskog & Sörbom, 1986). The relationship between latent variables or constructs given in a theoretical perspective is established in structural equation models. The measurement model and the structural model are the two parts of the structural equation models. How the latent variables or hypothetical constructs are measured in terms of the observed variables is specified in the measurement model. In addition, the measurement properties of these latent variables such as reliability and validity are described. On the other hand, the structural model gives the direct and direct relationships among latent variables. It also describes the amount of explained and unexplained variance (Schumacker & Lomax, 1996).

7. Measurement Model

How the latent variables or hypothetical constructs are measured in terms of the observed variables is specified in the measurement model. The relationships between the observed variables and the latent variables are described on the basis of the factor loadings. By the factor loadings, the information about the extent to which a given observed variable is able to measure the latent variable is provided. In addition, the measurement properties of the latent variables such as reliability and validity are described in the measurement model (Schumacker and Lomax, 1996).

8. Structural Model

The structural model gives the direct and indirect relationships among latent variables. The structural model describes the amount of explained and unexplained variance. Therefore, the indication of the extent to which hypothesized relationship are supported by the sample data is resulted from the structural model (Schumacker & Lomax, 1996).

9. Structural Equation Modeling

The structural equation modeling is an approach to develop measurement models in order to define latent variables and to establish relationships or structural equations among the latent variables (Schumacker & Lomax, 1996).

10. LISREL 8.30 with SIMPLIS Command Language

LISREL is a computer program (Jöreskog & Sörbom, 1992) performing structural equation modeling. The SIMPLIS command language has the advantage of moving away from the matrix formulation of the LISREL model. A more national language is used in SIMPLIS language to define LISREL models (Kelloway, 1998).

11. The Measurement Coefficients

The λ_y (lowercase lambda sub y) and λ_x (lowercase lambda sub x) values indicate the relationships between the latent variables and observed variables. These coefficients are also referred to as factor loadings. These coefficients serve as a validity coefficient.

The ε (lowercase epsilon) and δ (lowercase delta) are the measurement errors for the Ys and Xs, respectively. They serve as a reliability coefficient (Schumacker & Lomax, 1996).

12. The Structure Coefficients

The β (lowercase beta) values indicate the strength and direction of the relationship among the latent dependent variables.

The γ (lowercase gamma) values indicate the strength and direction of the relationship among latent dependent variables and latent independent variables (Schumacker and Lomax, 1996).

3.8.2 The Characteristic of Applications of Structural Equation Modeling

The five stages characteristic of applications of structural equation modeling (Bollen & Long, 1993) are explained below:

1. Model Specification

Specification of a model is the foremost requirement for any form of structural equation modeling. The propositions composing the model are most frequently drawn on the basis of a review of the research literature or a theory. The purpose of the hypothesized model is to explain the reasons of the correlated variables in a particular fashion. However, a unique model including all the variables of this study was not found in the literature.

2. Identification

The estimation of unknown parameters, for instance, factor loadings or path coefficients, based on observed covariances or correlations is involved in the application of structural equation modeling techniques. Issues of identification deal with whether unique values can be found for the parameters to be estimated in the theoretical model.

3. Estimation

There are software packages such as LISREL designed to solve sets of structural equations. LISREL solves the equations on the basis of using numerical methods to estimate parameters. LISREL solves the parameters in the model by a process of iterative estimation. There are various estimation techniques depending on the variable scale and/or distributional property of the variable(s) used in the model. The very common fitting criteria are ordinary least squares (OLS), generalized least squares (GLS) and maximum likelihood (ML). Since maximum likelihood estimators are consistent and asymptotically efficient in large samples, maximum likelihood estimation is the method of choice in this study.

4. Testing Fit

Interpreting model fit or comparing fit indices for alternative or nested models is involved in testing fit of the model. There are numerous fit indices, each having slightly different conception of what it means to say model fits the data. Multiple measures of fit indices can be used with the varying definitions of model fit. Moreover, the literature provides the basis for a strategy of model testing on several fundamental points.

5. Respecification

Improving either the parsimony or the fit of the model is the goal of model respecification (MacCallum, 1986). When the model fit indices suggest a poor fit, structural equation programs such as LISREL commonly provide some guidelines for finding sources of model misspecification. The development of the models is acquired by the modification indices and parameter tests. On the basis of the modification indices and parameter tests, some decisions are made about how to delete, add or modify paths in the model. When the model is modified, the model is reassessed on the same data. In this study, non-significant paths were deleted from the models of each country and modification suggestions were considered and applied to each country's models. Finally, the models were reassessed again.

3.8.3 The Goodness-of-Fit Criteria for Structural Equation Modeling

There are various structural equation modeling programs for the structural equation modeling. LISREL 8.30 for Windows with SIMPLIS command language was used in formulating and estimating the models of each country including factors affecting mathematical literacy of 15-year-old students participated in PISA 2000 in Brazil, Japan and Norway.

The goodness-of-fit criteria reported in LISREL 8.30 with SIMPLIS command language are given in the Table 3.16.

Table 3.16 Goodness-of-Fit Criteria in LISREL 8.30-SIMPLIS

	GOF Criteria
LISREL 8.30-SIMPLIS	Chi-Square
	Noncentrality-Parameter
	Minimum Fit Function
	Root-Mean-Square Error (RMSEA)
	Expected Cross Validation Index (ECVI)
	Akaike Information Criterion (AIC)
	Bozdogan Consistent AIC (CAIC)
	Root-Mean Square Residual (RMR)
	Goodness-of-Fit Index (GFI)

Table 3.16 (Continued)

	GOF Criteria
LISREL 8.30-SIMPLIS	Adjusted Goodness-of-Fit Index (AGFI) Parsimonious Goodness-of-Fit Index (PGFI) Normed Fit Index (NFI) Non-Normed Fit Index (NNFI) Parsimonious Normed Fit Index (PNFI) Comparative Fit Index (CFI) Incremental Fit Index (IFI) Relative Fit Index (RFI) Critical N (CN)

As said, there are various model fit indices in order to determine the degree to which the structural equation model fits the sample data. The differences between the observed and model-implied correlation or covariance matrix are considered in these criteria.

Goodness-of-fit criteria for structural equation modeling and their interpretations can be explained as the following:

1. Chi-Square (χ^2)

A non-significant χ^2 implies non-significant difference between the covariance matrix implied by the model and the population covariance matrix. A non-significant χ^2 means that the model fits the data. Therefore, the population covariance matrix can be reproduced by the model (Kelloway, 1998). The χ^2 criterion is very sensitive to sample size. Because the χ^2 criterion has a tendency to indicate a significant probability level when the sample size increases, generally above 200 (Schumacker & Lomax, 1996). As a result, a non-significant test statistic can be obtained with large samples.

2. Goodness-of-Fit Index (GFI)

A ratio of the sum of the squared differences between the observed and reproduced matrices to the observed variances is the base of the GFI (Schumacker & Lomax, 1996). The range of the GFI is from 0 to 1. The values exceeding 0.9 indicates a good fit to the data (Kelloway, 1998).

3. Adjusted Goodness-of-Fit Index (AGFI)

The AGFI index is the adjusted GFI for the degrees of freedom of a model relative to the number of variables (Schumacker & Lomax, 1996). As GFI, the AGFI has a range from 0 to 1, with values 0.9 indicating a good fit to the data (Kelloway, 1998).

The fit of two different models with the same data or the fit of models with different data can be compared by using the GFI and AGFI indices (Schumacker & Lomax, 1996).

4. Root-Mean-Square Residual (RMR)

The RMR is the square root of the mean of the squared differences between the implied and observed covariance matrices. A good fit is indicated by the low values of RMR whose lower bound is 0. Because of the difficulty of determining what a low value is, the standardized RMR is provided by LISREL. The standardized RMR has a lower bound of 0 and an upper bound of 1. For the interpretation of indicating a good fit to the data, values less than 0.05 are generally accepted (Kelloway, 1998).

5. Root-Mean-Squared Error of Approximation (RMSEA)

The RMSEA which was developed by Steiger (1990) is computed on the basis of the analysis of residuals. Smaller values of RMSEA indicate a better fit to the data. According to Steiger, values below 0.10 indicate a good fit, values below 0.05 indicate a very good fit and the rarely obtained values below 0.01 indicate an outstanding fit to the data. Going beyond point estimates to the provision of 91% confidence intervals for the point estimate is an important advantage of the RMSEA. In addition, a test of the significance of the RMSEA is provided by the LISREL. Whether the value of RMSEA is significant or not can be obtained by this test (Kelloway, 1998).

6. Normed Fit Index (NFI)

The NFI is based on the percentage improvement in fit over the baseline independence model (Bentler & Bonett. 1980). The NFI has a lower bound 0 and an upper bound of 1. A NFI of 0.90 means that the model is 90% better fitting than the null model. In spite of the widely usage of the NFI, it has a disadvantage of underestimating the fit of the model with small samples (Kelloway, 1998).

7. Non-Normed Fit Index (NNFI)

The NNFI is the adjusted NFI for the number of degrees of freedom in the model. Although the NNFI overcomes the disadvantage of underestimating, another problem of obtaining numbers outside the range of 0 to1 arises. The lower bound of NNFI is 0, but the upper bound of NNFI is greater than 1. For a better fitting model, higher values of NNFI of 0.90 indicate a good fit of the model to the data (Kelloway, 1998).

8. Comparative Fit Index (CFI)

The CFI is proposed by Bentler (1990) on the basis of noncentral χ^2 distribution. The range of CFI is from 0 to 1, with the values exceeding 0.90 indicating a good fit to the data.

9. Incremental Fit Index (IFI)

The IFI is based on the scaling factor (Bollen, 1989). The range of IFI is from 0 to 1. The higher values of IFI indicate a better fit to the data.

10. Relative Fit Index (RFI)

The RFI is based on assessing the fit of the indicator variables to the latent variables (Schumacker & Lomax, 1996). The range of RFI is from 0 to 1. The values of RFI approaching unity indicate a good fit to the data (Kelloway, 1998).

11. Relative Normed Fit Index (RNFI)

The RNFI is the adjusted RFI in order to estimate the effects of structural model from the measurement model separately (Schumacker & Lomax, 1996).

12. Cross-Validation Index

The usage of cross-validation index is suggested by Cudeck and Browne (1983). In cross-validation, two samples such as a calibration sample and a validation sample are required. Firstly, a model was set to the calibration sample. Then, the discrepancy between the covariance matrix of validation sample was evaluated. The model fits the data with the small discrepancy values. Because of the requirement of two samples, the expected value of the cross-validation index was estimated by Browne and Cudeck (1989). The expected value of cross-validation index uses data from a single sample.

13. Expected Value of Cross-Validation Index (ECVI)

The ECVI is the estimation of the expected discrepancy over all possible calibration samples. The lower bound of ECVI is 0, but the ECVI does not have an upper bound. Smaller values are given for the better fitting models. LISREL provides not only the point estimate of the ECVI, but also the confidence intervals for the estimate. In addition, the ECVI values for the independence (null) and saturated (just-identified) models are calculated by LISREL.

14. Normed Chi-Square (NC)

The NC is the adjusted Chi-Square on the basis or the ratio of the χ^2 and its degrees of freedom. χ^2 / df ratios of less than 5 indicate a good fit to the data, like ratios between 2 and 5. Moreover, χ^2 / df ratios of less than 2 indicate overfitting (Kelloway, 1998).

15. Parsimonious Fit Index (PFI)

The number of degrees of freedom used to obtain a given level of fit is taken into account for PFI. High degree of fit is obtained with fewer degrees of freedom for parsimony (Schumacker & Lomax, 1996). The PFI is the modified NFI measure (James, Mulaik & Brett, 1982).

16. Parsimonious Normed Fit Index (PNFI)

The PNFI is the adjusted NFI for parsimony. The PNFI ranges from 0 to 1. Higher values indicate a more parsimonious fit (Kelloway, 1998).

17. Parsimonious Goodness-of-Fit Index (PGFI)

The PGFI is the adjusted GFI for the degrees of freedom. Like PNFI, the PGFI ranges from 0 to 1, with higher values indicating a more parsimonious fit (Kelloway, 1998).

In order to indicate parsimonious fit, there is no standard for how high either PNFI or PGFI index should be. Compared with other fit indices, 0.90 cutoff is not expected to be obtained for both PNFI and PGFI indices. Because of the usage of these indices for comparing two competing theoretical models, the model with the highest level of parsimonious fit is selected (Kelloway, 1998).

CHAPTER 4

RESULTS

This chapter is devoted to the presentation of the results of the present study. Two main sections such as preliminary studies and structural equation modeling are included in this chapter. In preliminary studies, the variances of the study were tested with respect to their frequency distributions. In addition, factor analyses were conducted in order to determine and examine the factors in accordance with the data for each country. In structural equation modeling, testing the models was conducted for the mathematical literacy models of each country and the models were separately explained for each country.

4.1 Preliminary Studies

Factor analyses are conducted in order to reduce the number of observed variables by grouping the variables in constructs. Factor analysis methods are general attempts to determine which sets of observed variables sharing common variance or covariance characteristics define constructs. Moreover, how the variables relate to factors can be explored by conducting factor analyses (Schumacker & Lomax, 1996).

A separate factor analysis was carried out for each questionnaire such as student questionnaire and cross-curricular competencies questionnaire in accordance within the data of each country. The results of the factor analyses conducted separately for each country were found as parallel to each other. Since the similar results obtained in each country, the observed variables representing the latent variables were selected in order to be used in structural equation modeling based on the results of factor analyses of each country data.

4.1.1 Results of Factor Analyses of Brazil

Firstly, 158 observed variables included in the student questionnaire were analyzed through the principle components factor analysis and 21 factors were obtained as the result of the factor analysis. Three criteria such as the priori hypothesis that the measure was unidimensional, the scree test and the interpretability of the factor solution were used so as to determine the number of factors to rotate. According to the scree test, 10 factors were indicated since the scree test indicated that the initial hypothesis of unidimensionality was incorrect. Therefore, another principle components factor analysis was conducted with the restriction of the number of factors as 10. After the 10 factors were rotated using a Varimax rotation procedure, the factors were examined through in order to determine the factors that would be included in the study. The 6 factors included in the study were determined with respect to the interest of investigation. The observed variables representing latent variables and their factor loadings were displayed in Table 4.1.

Table 4.1 Principle Component Factor Analysis Results of Student Questionnaire for Brazil

	Factor Loadings					
Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Fictions	.753	-	-	-	-	-
Favourite Hobby	.712	-	-	-	-	-
Feel Happy	.677	-	-	-	-	-
Enjoy Library	.659	-	-	-	-	-
Talking about Books	.653	-	-	-	-	-
Borrow Books	.629	-	-	-	-	-
Non-Fiction	.625	-	-	-	-	-
Read each Day	.577	-	-	-	-	-
How Many Books at Home	.449	-	-	-	-	-
Comics	.433	-	-	-	-	-
Newspapers	.430	-	-	-	-	-

Table 4.1 (Continued)

Listen to Me	-	.699	-	-	-	-
Interested in Students	-	.692	-	-	-	-
Give Extra Help	-	.987	-	-	-	-
Treat Me Fairly	-	.680	-	-	-	-
Well with Students	-	.655	-	-	-	-
Feel I Belong	-	.573	-	-	-	-
Make Friends	-	.536	-	-	-	-
Think I'm Liked	-	.525	-	-	-	-
Teachers Comment On	-	.451	-	-	-	-
Is Interesting	-	.444	-	-	-	-
Teachers Grade	-	.410	-	-	-	-
I Finish at School	-	.376	-	-	-	-
Is Counted in Mark	-	.367	-	-	-	-
Miss School	-	.286	-	-	-	-
Noise & Disorder	-	-	.685	-	-	-
Doing Nothing	-	-	.676	-	-	-
Students Don't Start	-	-	.665	-	-	-
Students Don't Listen	-	-	.634	-	-	-
Teachers Wait Long Time	-	-	.550	-	-	-
Students Cannot Work Well	-	-	.530	-	-	-
Teachers Don't Like	-	-	.416	-	-	-
Students Learn a Lot	-	-	.412	-	-	-
Late for School	-	-	.289	-	-	-
Skip Classes	-	-	.284	-	-	-
Just Talking	-	-	-	.714	-	-
Discuss Books	-	-	-	.675	-	-
Discuss School Problems	-	-	-	.643	-	-
Eat Main Meal	-	-	-	.632	-	-
Discuss Politics	-	-	-	.600	-	-
Listen Classics	-	-	-	.428	-	-
How Often use Computers	-	-	-	-	.788	-
How Often Use Internet	-	-	-	-	.761	-
How Often Use Sci. Labs	-	-	-	-	.662	-
How Often Use Calculators	-	-	-	-	.638	-
How Often Use Sch. Library	-	-	-	-	.480	-
Only if I Have To	-	-	-	-	-	.740
Few Minutes Only	-	-	-	-	-	.735
Waste of Time	-	-	-	-	-	.707
Hard to Finish	-	-	-	-	-	.689
For Information	-	-	-	-	-	.679
I Do Watching TV	-	-	-	-	-	.352

The first and sixth factors were about engagement in reading and enjoyment in reading, respectively. In order to obtain a general construct as attitude towards reading, these two factors were combined in a factor. As a result, the selected five factors in the rotated solution were attitudes towards reading, student-teacher relations, climate, communication with parents and usage of technology and facilities. The factors were interpreted with names on the basis of the meanings and the size of the loadings of the statements included. The eigenvalues, the percentage and the cumulative percentage of the explained variance of the factors were given in Table 4.2.

Table 4.2 Rotation Sums of Squared Loadings of Students Questionnaire for Brazil

Factors	Eigenvalue	% of Variance	Cumulative %
Attitude towards Reading	12.013	7.503	7.503
Student-Teacher Relations	6.987	4.422	11.945
Climate	4.970	3.146	15.091
Communication with Parents	3.367	2.131	17.222
Usage of Technology and Facilities	3.124	1.977	19.199

As the factor analysis of student questionnaire, the factor analysis of cross-curricular competencies questionnaire was conducted among 52 variables included in the questionnaire. According to the results of the principle components factor analysis of cross-curricular competencies questionnaire, the observed variables were grouped under 2 factors. The factors were investigated and only one factor was decided to be included in the study. The observed variables representing latent variable and their factor loadings were shown in Table 4.3.

Table 4.3 Principle Component Factor Analysis Results of Cross-Curricular Competencies Questionnaire for Brazil

Items	Factor Loadings of Factor
Learn Faster	.794
Well in Tests	.793
Good Marks	.788
Help Others	.786
Done Well	.785
Helpful Ideas	.779
Like to be Best	.779
Trying Better	.779
Good Marks Math	.778
Math Best	.778
Best Work	.774
Read Absorbed	.772
Math Fun	.772
Read Spare	.764
Learn Most	.764
Learn Quickly	.762
Math Important	.761
Good Most	.758
Better	.750
Reading Fun	.749
Hopeless	.740
Like Other	.738
Quickly in Most	.737
Math Absorbed	.729
Additional Information	.669
Can Master	.667
Best Effort	.663

The selected factor was named as attitudes towards mathematics based on the size of the loadings and the meanings of the statements included. The eigenvalues, the percentage and the cumulative percentage of the explained variance of the factor were displayed in Table 4.4.

Table 4.4 Rotation Sums of Squared Loadings of Cross-Curricular Competencies Questionnaire for Brazil

Factor	Eigenvalue	% of Variance	Cumulative %
Attitudes towards Mathematics	23.232	44.677	44.677

After the selection of 5 factors from the student questionnaire and 1 factor from the cross-curricular competencies questionnaire, the observed variables representing the factors were examined through in order to reduce the number of observed variables that would be included in the structural equation modeling. Because too many observed variables included in the structural equation modeling would cause senseless or meaningless. In addition, the models would be very complex and confusing. The observed variables that would be included in the structural equation modeling were determined in accordance with the meanings and the size of factor loadings. The selected observed variables representing latent variables on the basis of the eigenvalues, the percentage and cumulative percentage of the explained variance and lastly the alpha values of reliability of the factors were given in Table 4.5.

Table 4.5 Rotation Sums of Squared Loadings and Reliability of Factors for Brazil

Observed Variables	Latent Variables	Eigenvalue	% of Variance	Cum. %	Reliability
Favourite Hobby	ATTREAD	3.793	12.236	12.236	0.89
Feel Happy					
Enjoy Library					
Talking about Books					
Only if I Have To					
Few Minutes Only					
Waste of Time					
Listen to Me	RELATION	2.651	8.551	20.787	0.91
Interested in Students					
Give Extra Help					
Treat Me Fairly					
Well with Students					

Table 4.5 (Continued)

Noise & Disorder					
Doing Nothing					
Students Don't Start					
Students Don't Listen	CLIMATE	2.851	9.079	29.866	0.85
Teachers Wait Long Time					
Students Cannot Work Well					
Just Talking					
Discuss Books					
Discuss Sch. Problems	COM	2.128	6.865	36.731	0.78
Eat Main Meal					
How Often Use Computers					
How Often Use Calculators	USAGE	1.420	4.580	41.311	0.78
How Often Use Sch. Library					
Done Well					
Good Marks Math					
Math Best					
Math Fun	ATTMATH	3.488	11.251	52.562	0.95
Math Important					
Math Absorbed					

4.1.2 Results of Factor Analyses of Japan

Firstly, 147 observed variables included in the student questionnaire were analyzed through the principle components factor analysis and 19 factors were obtained as the result of the factor analysis. After the 19 factors were rotated using a Varimax rotation procedure, the common factors with the Brazil data were selected. The 5 factors included in the study were determined with respect to the selected observed from Brazil data. The observed variables representing latent variables and their factor loadings were displayed in Table 4.6.

Table 4.6 Principle Component Factor Analysis Results of Student Questionnaire for Japan

	Factor Loadings					
Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Fictions	.764	-	-	-	-	-
Favourite Hobby	.756	-	-	-	-	-
Feel Happy	.709	-	-	-	-	-
Non-Fiction	.704	-	-	-	-	-
Borrow Books	.699	-	-	-	-	-
Talking about Books	.695	-	-	-	-	-
Read each Day	.693	-	-	-	-	-
How Often Use School Library	.681	-	-	-	-	-
Enjoy Library	.663	-	-	-	-	-
Homework Test Language	.649	-	-	-	-	-
Homework Maths	.625	-	-	-	-	-
Homework Science	.624	-	-	-	-	-
Is Interesting	.523	-	-	-	-	-
How Many Books at Home	.506	-	-	-	-	-
How Often Use Internet	.490	-	-	-	-	-
I Complete On Time	.480	-	-	-	-	-
Newspapers	.475	-	-	-	-	-
Art Gallery	.471	-	-	-	-	-
Miss School	.445	-	-	-	-	-
Skip Classes	.438	-	-	-	-	-
How Often Use Science Labs	.432	-	-	-	-	-
Comics	.426	-	-	-	-	-
Late for School	.407	-	-	-	-	-
Theatre	.375	-	-	-	-	-
I Finish at School	.276	-	-	-	-	-
Classics	.358	-	-	-	-	-
Listen Classics	.253	-	-	-	-	-
Feel I Belong	.255	-	-	-	-	-
Movies	.284	-	-	-	-	-
Interested in Students	-	.547	-	-	-	-
Listen to Me	-	.547	-	-	-	-
Give Extra Help	-	.530	-	-	-	-
Treat me Fairly	-	.495	-	-	-	-
Well with Students	-	.440	-	-	-	-
Teachers Do a lot to Help	-	-	.808	-	-	-
Teachers Help with Learning	-	-	.800	-	-	-
Teachers Help with Work	-	-	.778	-	-	-
Teachers Continue Teaching	-	-	.756	-	-	-
Teachers Show Interest	-	-	.728	-	-	-
Teachers Give Opportunity	-	-	.703	-	-	-
Teachers Want Stud. to Work	-	-	.626	-	-	-
Teachers Check Homework	-	-	.590	-	-	-

Table 4.6 (Continued)

Students Learn a Lot	-	-	.575	-	-	-
Students Cannot Work Well	-	-	.570	-	-	-
Students Don't Listen	-	-	.524	-	-	-
Teachers Tell Stud. Do Better	-	-	.501	-	-	-
Teachers Don't Like	-	-	.492	-	-	-
Teachers Wait Long Time	-	-	.485	-	-	-
Noise & Disorder	-	-	.475	-	-	-
Students Don't Start	-	-	.473	-	-	-
Teachers Comment On	-	-	.464	-	-	-
Doing Nothing	-	-	.452	-	-	-
Teachers Grade	-	-	.422	-	-	-
Is Counted in Mark	-	-	.380	-	-	-
Think I'm Liked	-	-	.377	-	-	-
Make Friends	-	-	.343	-	-	-
Discuss Books	-	-	-	.671	-	-
Just Talking	-	-	-	.639	-	-
Discuss School Problems	-	-	-	.633	-	-
Discuss Politics	-	-	-	.531	-	-
Eat Main Meal	-	-	-	.455	-	-
School Program	-	-	-	-	.763	-
How Often Use Calculators	-	-	-	-	.577	-
How Often use Computers	-	-	-	-	.513	-
Only if I Have To	-	-	-	-	-	.739
Few Minutes Only	-	-	-	-	-	.667
Hard to Finish	-	-	-	-	-	.663
Waste of Time	-	-	-	-	-	.620
For Information	-	-	-	-	-	.576

As done in the Brazil data, the first and sixth factors were about engagement in reading and enjoyment in reading, respectively. In order to obtain a general construct as attitude towards reading, these two factors were combined in a factor. As a result, the selected five factors in the rotated solution were common factors with Brazil data and these factors were attitudes towards reading, student-teacher relations, climate, communication with parents and usage of technology and facilities. The factors were interpreted with names on the basis of the meanings and the size of the loadings of the statements included. The eigenvalues, the percentage and the cumulative percentage of the explained variance of the factors were given in Table 4.7.

Table 4.7 Rotation Sums of Squared Loadings of Students Questionnaire for Japan

Factors	Eigenvalue	% of Variance	Cumulative %
Attitude towards Reading	21.279	14.475	14.475
Student-Teacher Relations	2.439	1.659	16.134
Climate	13.088	8.903	25.037
Communication with Parents	3.957	2.692	27.729
Usage of Technology and Facilities	1.806	1.229	28.958

Since the cross-curricular competencies questionnaire was an optional questionnaire and it was not administered in Japan, the students in Japan did not report their ideas to the statements in this questionnaire. Consequently, the data for the cross-curricular competencies questionnaire was not collected across Japan.

After the selection of 5 factors from the student questionnaire, the observed variables representing the factors were examined through in order to reduce the number of observed variables that would be included in the structural equation modeling. Because too many observed variables included in the structural equation modeling would cause senseless or meaningless. In addition, the models would be very complex and confusing. The observed variables that would be included in the structural equation modeling were determined in accordance with the meanings and the size of factor loadings. The selected observed variables representing latent variables on the basis of the eigenvalues, the percentage and cumulative percentage of the explained variance and lastly the alpha values of reliability of the factors were given in Table 4.8.

Table 4.8 Rotation Sums of Squared Loadings and Reliability of Factors for Japan

Observed Variables	Latent Variables	Eigenvalue	% of Variance	Cum. %	Reliability
Favourite Hobby	ATTREAD	4.040	16.160	16.160	0.89
Feel Happy					
Enjoy Library					
Talking about Books					
Only if I Have To					
Few Minutes Only					
Waste of Time					

Table 4.8 (Continued)

Listen to Me	RELATION	3.112	12.447	28.607	0.94
Interested in Students					
Give Extra Help					
Treat Me Fairly					
Well with Students					
Noise & Disorder	CLIMATE	3.176	12.706	41.313	0.92
Doing Nothing					
Students Don’t Start					
Students Don’t Listen					
Teachers Wait Long Time					
Students Cannot Work Well					
Just Talking	COM	2.094	8.376	49.689	0.79
Discuss Books					
Discuss Sch. Problems					
Eat Main Meal					
How Often Use Computers	USAGE	1.482	5.928	55.617	0.78
How Often Use Calculators					
How Often Use Sch. Library					

4.1.3 Results of Factor Analyses of Norway

Firstly, 153 observed variables included in the student questionnaire were analyzed through the principle components factor analysis and 31 factors were obtained as the result of the factor analysis. Three criteria such as the priori hypothesis that the measure was unidimensional, the scree test and the interpretability of the factor solution were used so as to determine the number of factors to rotate. According to the scree test, 12 factors were indicated since the scree test indicated that the initial hypothesis of unidimensionality was incorrect. Therefore, another principle components factor analysis was conducted with the restriction of the number of factors as 12. After the 12 factors were rotated using a Varimax rotation procedure, the factors were examined through in order to determine the factors that would be included in the study. The 6 factors included in the study were determined with respect to the interest of investigation. The observed variables representing latent variables and their factor loadings were displayed in Table 4.9.

Table 4.9 Principle Component Factor Analysis Results of Student Questionnaire for Norway

	Factor Loadings					
Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Favourite Hobby	.771	-	-	-	-	-
Feel Happy	.763	-	-	-	-	-
Talking about Books	.751	-	-	-	-	-
Enjoy Library	.728	-	-	-	-	-
Fictions	.561	-	-	-	-	-
Read each Day	.535	-	-	-	-	-
Borrow Books	.474	-	-	-	-	-
Listen to Me	-	.718	-	-	-	-
Treat Me Fairly	-	.707	-	-	-	-
Interested in Students	-	.699	-	-	-	-
Well with Students	-	.697	-	-	-	-
Give Extra Help	-	.681	-	-	-	-
Feel I Belong	-	.532	-	-	-	-
Make Friends	-	.487	-	-	-	-
Think I'm Liked	-	.437	-	-	-	-
Noise & Disorder	-	-	.744	-	-	-
Students Don't Start	-	-	.731	-	-	-
Doing Nothing	-	-	.726	-	-	-
Teachers Wait Long Time	-	-	.655	-	-	-
Students Don't Listen	-	-	.651	-	-	-
Students Cannot Work Well	-	-	.574	-	-	-
Discuss School Problems	-	-	-	.739	-	-
Just Talking	-	-	-	.723	-	-
Eat Main Meal	-	-	-	.632	-	-
Discuss Books	-	-	-	.562	-	-
Discuss Politics	-	-	-	.468	-	-
How Often Use Computers	-	-	-	-	.826	-
How Often Use Internet	-	-	-	-	.821	-
How Often Use School Library	-	-	-	-	.636	-
How Often Use Science Labs	-	-	-	-	.495	-
How Often Use Calculators	-	-	-	-	.468	-
Waste of Time	-	-	-	-	-	.771
Only if I Have To	-	-	-	-	-	.761
For Information	-	-	-	-	-	.755
Few Minutes Only	-	-	-	-	-	.743
Hard to Finish	-	-	-	-	-	.701

The first and sixth factors were about engagement in reading and enjoyment in reading, respectively. In order to obtain a general construct as attitude towards reading, these two factors were combined in a factor. As a result, the selected five factors in the rotated solution were attitudes towards reading, student-teacher relations, climate, communication with parents and usage of technology and facilities. The factors were interpreted with names on the basis of the meanings and the size of the loadings of the statements included. The eigenvalues, the percentage and the cumulative percentage of the explained variance of the factors were given in Table 4.10.

Table 4.10 Rotation Sums of Squared Loadings of Students Questionnaire for Norway

Factors	Eigenvalue	% of Variance	Cumulative %
Attitude towards Reading	8.564	5.598	5.598
Student-Teacher Relations	4.524	2.957	8.555
Climate	4.588	2.999	11.554
Communication with Parents	2.625	1.715	13.269
Usage of Technology and Facilities	2.883	1.884	15.153

As the factor analysis of student questionnaire, the factor analysis of cross-curricular competencies questionnaire was conducted among 52 variables included in the questionnaire. According to the results of the principle components factor analysis of cross-curricular competencies questionnaire, the observed variables were grouped under 5 factors. The factors were investigated and only one factor was decided to be included in the study. The observed variables representing latent variable and their factor loadings were shown in Table 4.11.

Table 4.11 Principle Component Factor Analysis Results of Cross-Curricular Competencies Questionnaire for Norway

Items	Factor Loadings of Factor
Math Best	.749
Math Fun	.716
Good Marks Math	.705
Done Well	.703
Math Important	.648
Math Absorbed	.625
Trying Better	.562
Hopeless	.528
Better	.523

The selected factor was named as attitudes towards mathematics based on the size of the loadings and the meanings of the statements included. The eigenvalues, the percentage and the cumulative percentage of the explained variance of the factor were displayed in Table 4.12.

Table 4.12 Rotation Sums of Squared Loadings of Cross-curricular Competencies Questionnaire for Norway

Factor	Eigenvalue	% of Variance	Cumulative %
Attitudes towards Mathematics	7.073	13.602	13.602

After the selection of 5 factors from the student questionnaire and 1 factor from the cross-curricular competencies questionnaire, the observed variables representing the factors were examined through in order to reduce the number of observed variables that would be included in the structural equation modeling. Because too many observed variables included in the structural equation modeling would cause senseless or meaningless. In addition, the models would be very complex and confusing. The observed variables that would be included in the structural equation modeling were determined in accordance with the meanings and the size of factor loadings. The selected observed variables representing latent variables on the basis of the eigenvalues, the percentage and cumulative percentage of the explained variance and lastly the alpha values of reliability of the factors were given in Table 4.13.

Table 4.13 Rotation Sums of Squared Loadings and Reliability of Factors for Norway

Observed Variables	Latent Variables	Eigenvalue	% of Variance	Cum. %	Reliability
Favourite Hobby Feel Happy Enjoy Library Talking about Books Only if I Have To Few Minutes Only Waste of Time	ATTREAD	4.064	13.110	13.110	0.82
Listen to Me Interested in Students Give Extra Help Treat Me Fairly Well with Students	RELATION	2.959	9.546	22.656	0.88
Noise & Disorder Doing Nothing Students Don’t Start Students Don’t Listen Teachers Wait Long Time Students Cannot Work Well	CLIMATE	3.363	10.849	33.505	0.88
Just Talking Discuss Books Discuss Sch. Problems Eat Main Meal	COM	2.033	6.558	40.063	0.69
How Often Use Computers How Often Use Calculators How Often Use Sch. Library	USAGE	1.416	4.568	44.631	0.69
Done Well Good Marks Math Math Best Math Fun Math Important Math Absorbed	ATTMATH	4.035	13.018	57.649	0.94

4.1.4 Results of Factor Analyses for the Present Study

All the factor analyses were conducted using principle components method and Varimax rotation procedure. The iterations were set as 100 iterations as an option and factor loadings below 0.1 were suppressed from the tables of the results. Moreover, all the factor analyses were carried out with the listwise deletion method.

The factor analyses were conducted through each country. Then the items with higher factor loadings were selected on the basis of the separate factor analyses results within each country. The items were determined in order to form the latent variables that would be included in model testing. Since the data cleaning process was done by the Consortium before, the recoding of the relevant items were provided in the data cleaning process. The latent variables and the observed variables are given below.

1. Student-Teacher Relations

The literature suggests the importance of the teacher behaviors. When the teacher is interested in the progress of the students and shows a willingness to help the students, students can benefit from the teaching practices. In PISA student questionnaire, the students were asked to indicate their ideas about the relationship between themselves and their teachers. They disagreed or agreed the given statements in the item.

2. Climate

The learning or disciplinary climate is another element of success of the students at school. The climate can affect the learning of the students with respect to their learning styles. Therefore, the climate at school is an important factor for the learning and the success of the students. In PISA student questionnaire, some of the statements were about the general view of the climate at school. The students selected the frequencies of the statements in the item.

3. Communication with the Parents

An essential element of success of the students at school is parents' support for their children's education. When the parents interact and communicate well with their children, they can have information about how their children are doing both in and out of school. Therefore, they can encourage and motivate their children with their interest. Previous research suggested that there is an important relationship between the parental involvement and the children's success. In PISA student questionnaire, students were asked some statements in order to get information about the interaction and communication with their parents. These statements indicated the cultural and social communication with their parents. The students selected the frequencies of the statements in the item.

4. The Usage of Technology and Facilities

The availability of a physical infrastructure and the adequate supply of educational resources are important for education. These can affect the performance and the learning of the students. The physical environment such as buildings in good condition and adequate amounts of teaching space is related to learning. Moreover, the adequate educational resources such as computers, calculators, library and teaching materials are also conducted to learning as well. In PISA student questionnaire, the statements indicated information about the physical environment and educational resources. The students selected the frequencies of the statements in the item.

5. Attitudes

The students setting their own learning goals and having a sense that they can reach these goals are potential learners. Motivation and engagement play an essential role in the students' quality of life. In addition, enjoyment of learning and activities promoting learning has an effect on motivation. The interest of the students in particular subjects is independent of the general motivation of the students to learn. The degree and continuity of engagement in learning and the depth of understanding reached are affected by the interest in particular subjects. Furthermore, the positive activities and engagement in particular subjects are not only essential for education, but also they are the predictors of learning success throughout the life. In general, the interest, motivation, enjoyment and engagement in particular subjects show the attitudes of the students towards the particular subjects.

In order to represent the attitudes of students towards reading and mathematics, some statements from the PISA student questionnaire and from the PISA cross-curricular competencies questionnaire were selected, respectively. The selection of the statements asked in questionnaires was made by the consideration of the interest, engagement and enjoyment in reading and mathematics. These selected statements were included in latent variables named attitudes towards reading and attitudes towards mathematics. The students disagreed or agreed the given statements in the items in questionnaires.

The latent variables and all the observed variables included are given in Table 4.14.

Table 4.14 Latent Variables and Observed Variables

Latent Variable	Observed Variables
Student-Teacher Relations (RELATION)	Listen to me (30c) Interested in students (30b) Give extra help (30d) Treat me fairly (30e) Well with students (30a)
Disciplinary Climate (DCLIMATE)	Noise and disorder (26e) Doing nothing (26f) Students don't start (26d) Students don't listen (26c) Teachers wait long time (26a) Students cannot work well (26b)
Communication with Parents (COM)	Just talking (19d) Discuss books (19a) Discuss school problems (19b) Eat main meal (19c)
Usage of Technology and Facilities (USAGE)	How often use computers (39b) How often use calculators (39c) How often use school library (39a)
Attitudes towards Reading (ATTREAD)	Favourite hobby (35b) Feel happy (35d) Enjoy library (35f) Talking about books (35c) Only if I have to (35a) Few minutes only (35g) Waste of time (35e)
Attitudes towards Mathematics (ATTMATH)	Done well (02e) Good marks Math (02c) Math best (02d) Math fun (02b) Math important (02f) Math absorbed (02a)

In PISA 2000, not all of the students responded to all of the mathematics and reading items. Therefore, student proficiencies or measures were not observed. Since there were missing data that could be inferred from the observed item responses, several possible alternative approaches could be applied for making this inference. PISA used two approaches such as maximum likelihood using Warm's (1985) Weighted Likelihood Estimator (WLE) and maximum likelihood using plausible values (PVs). Plausible values are a selection of likely proficiencies for students that attained each score. The plausible values are not text scores and should not be treated as such. They are random numbers drawn from the distribution of scores that could be reasonably assigned to each individual (Adams, 2002). Therefore in this study, five overall mathematics literacy plausible values from PV1MATH to PV5MATH and five combined reading literacy plausible values from PV1READ to PV5READ were used. These plausible values were observed variables to represent the mathematical literacy and reading literacy latent variables. Because of the high standards for quality of the PISA 2000 design, test instruments were assumed to be highly valid and reliable.

Consequently, the selected observed variables that would be included in the structural equation modeling, and the names used in interpreting the observed variables in the structural equation models were displayed in Table 4.15.

Table 4.15 Names of Observed Variables Representing Latent Variables

Observed Variables	Given Names	Latent Variables
Favourite Hobby	Favhobby	ATTREAD
Feel happy	Feelhapp	
Enjoy Library	Enjoylib	
Talking about Books	Talkbook	
Only if I Have To	Rehaveto	
Few Minutes	Fewminut	
Waste of Time	Wastetim	
Listen to Me	Listenme	RELATION
Interested in Students	Interest	
Give Extra Help	Extrhelp	
Treat Me Fairly	Treafair	
Well with Students	Wellstud	

Table 4.15 (Continued)

Noise & Disorder	Noise	CLIMATE
Doing Nothing	Nothing	
Students Don't Start	Notstart	
Students Don't Listen	Nolisten	
Teachers Wait Long Time	Longtime	
Students Cannot Work Well	Noworkwe	
Just Talking	Justtalk	COM
Discuss Books	Discussb	
Discuss School Problems	Discussp	
Eat Main Meal	Mainmeal	
How Often use Computers	Usecompu	USAGE
How Often Use Calculators	Calculat	
How Often Use Sch. Library	Schoolib	
Done Well	Mdonewel	ATTMATH
Good Marks Math	Mgoodmar	
Math Best	Mathbest	
Math Fun	Mathfun	
Math Important	Mathimpo	
Math Absorbed	Mabsorbe	
1st Plausible Value of Math Scores	Pv1math	MATHLIT
2nd Plausible Value of Math Scores	Pv2math	
3rd Plausible Value of Math Scores	Pv3math	
4th Plausible Value of Math Scores	Pv4math	
5th Plausible value of Math Scores	Pv5math	
1st Plausible Value of Reading Scores	Pv1read	READLIT
2nd Plausible Value of Reading Scores	Pv2read	
3rd Plausible Value of Reading Scores	Pv3read	
4th Plausible Value of Reading Scores	Pv4read	
5th Plausible Value of Reading Scores	Pv5read	

The reliability analysis was conducted separately for each latent variable through each country in order to obtain the internal-consistency estimates of reliability. The alpha reliability coefficients of the latent variables including observed variables for each country are given in Table 4.16.

Table 4.16 The Observed and Latent Variables, and Reliabilities of Latent Variables

		Alpha	Reliability	Coefficients
Observed Variables	Latent Variables	Brazil	Japan	Norway
Listen to me Interested in students Give extra help Treat me fairly Well with students	RELATION	0.91	0.94	0.88
Noise and disorder Doing nothing Students don't start Students don't listen Teachers wait long time Students cannot work well	CLIMATE	0.85	0.92	0.88
Just talking Discuss books Discuss school problems Eat main meal	COM	0.78	0.79	0.69
How often use computers How often use calculators How often use school library	USAGE	0.78	0.78	0.69
Favourite hobby Feel happy Enjoy library Talking about books Only if I have to Few minutes only Waste of time	ATTREAD	0.90	0.88	0.83
Done well Good marks Math Math best Math fun Math important Math absorbed (02a)	ATTMATH	0.95	-*	0.94

**The data about attitudes towards mathematics is not available for Japan.*

The alpha reliability coefficients of the Mathematics Scale and Reading Scale were separately calculated through each country by conducting a reliability analysis, respectively. The observed and latent variables and the alpha reliability coefficients of the mathematics and reading scales for each country are given in Table 4.17.

Table 4.17 The Alpha Reliability Coefficients of Mathematics and Reading Scale

		Alpha Reliability Coefficients		
Observed Variables	Latent Variables	Brazil	Japan	Norway
PV1READ PV2READ PV3READ PV4READ PV5READ	Reading Literacy (READLIT)	0.98	0.98	0.99
PV1MATH PV2MATH PV3MATH PV4MATH PV5MATH	Mathematical Literacy (MATHLIT)	0.96	0.97	0.97

After the observed variables that would be contained in the structural equation modeling were determined, they were examined with respect to their frequency distributions. The goal of finding frequency distributions of the observed variables was to see the general pattern of the responses of the students. By the help of the frequency distributions of the observed variables, the most selected alternatives, the least selected alternatives and the percentages of the responses given to alternatives of the statements in the questionnaires could be investigated for each country. The frequency distribution tables of each of the observed variables selected from the questionnaires with respect to each country were displayed in Appendix A.

4.2 Structural Equation Modeling

After factor analyses were conducted on the basis of each questionnaire for each country, the observed variables representing the latent variables that would be included in the structural equation modeling were determined. The data file containing all the included observed variables was organized and imported into PRELIS 2.30 for Windows for each country. Later on, the data screening was conducted on the final data of each country, separately. After the data files were imported into PRELIS 2.30 for Windows and necessary steps were acquired, LISREL 8.30 for Windows with SIMPLIS command language was conducted for formulating and estimating the structural equation models of the 15-year-old students in Brazil, Japan and Norway. All the structural equation modeling analyses were conducted by using the listwise deletion method in missing values analyses and the method Maximum Likelihood in modeling analyses. Moreover, in all the analyses, significance level of 0.05 is used.

4.2.1 The Mathematical Literacy Model for Brazil

At the beginning, the actual model presented in Chapter 1 was tested with Brazil data. Afterwards, the path from the latent variable, ATTREAD, to the observed variable, SCHOOLIB, was constructed on the basis of the modification index. Later on, fifteen covariance terms were added to the SIMPLIS syntax in order to improve the model considering the highest meaningful modification indices. The final SIMPLIS syntax for Mathematics Literacy Model for Brazil can be found in the first section of the Appendix B. LISREL estimates of parameters in structural model of Brazil in which the coefficients were in standardized values was presented in Figure 4.1. Moreover, the Figure 4.2 displayed LISREL estimates of parameters in structural model of Brazil in which the coefficients were in t-values. Besides, LISREL estimates of parameters in measurement model of Brazil with coefficients in standardized value and t-values can be found in the first part of Appendix C.

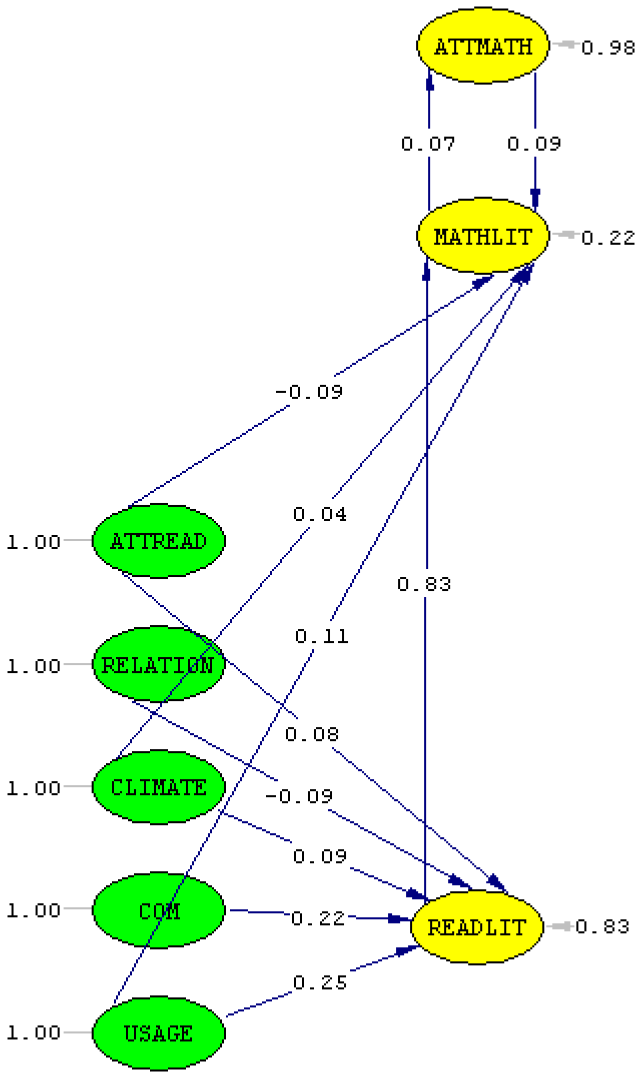

Figure 4.1 LISREL Estimates of Parameters in Structural Model of Brazil (Coefficients in Standardized Value)

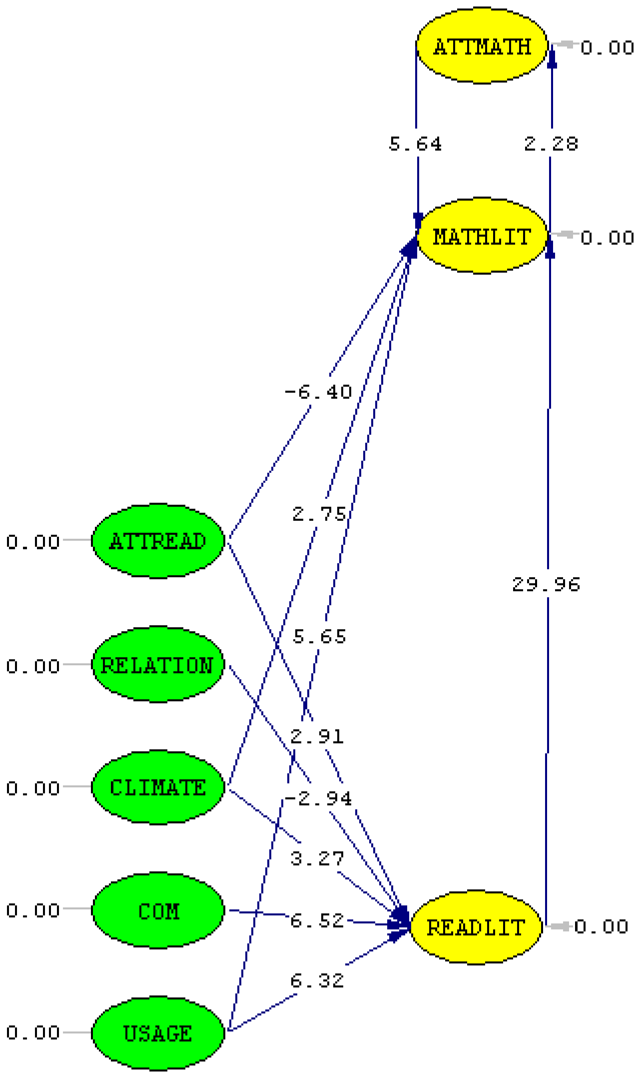

Figure 4.2 LISREL Estimates of Parameters in Structural Model of Brazil (Coefficients in t-Values)

As can be seen easily from the Figure 4.1, the structural equation model was consisted of five latent independent variables and three latent dependent variables. The latent independent variables were Attitudes towards Reading (ATTREAD), Student-Teacher Relations (RELATION), Climate (CLIMATE), Communication with Parents (COM) and Usage of Technology and Facilities (USAGE) while the latent dependent variables were Attitudes towards Mathematics (ATTMATH), Mathematical Literacy (MATHLIT) and Reading Literacy (READLIT). Done well (mdonewel), Good marks math (mgoodmar), Math best (mathbest), Math fun (mathfun), Math important (mathimpo) and Math absorbed (mabsorbe) were the observed variables of the latent dependent variable ATTMATH. The five plausible values of Math scores from Pv1math to Pv5math were the observed variables of the latent dependent variable MATHLIT. Finally, the latent dependent variable READLIT was consisted of the five plausible values of Reading scores from Pv1read to Pv5read.

Since the measurement coefficients were defined before in Chapter 3, the λ_y (lowercase lambda sub y) and the λ_x (lowercase lambda sub x) values indicate the relationships between the latent variables and the observed variables. Moreover, the ε (lowercase epsilon) and δ (lowercase delta) are the measurement errors for the Ys and Xs, respectively. All these measurement coefficients for mathematical literacy model for Brazil were given in standardized values in Table 4.18.

Table 4.18 Measurement Coefficients of Mathematical Literacy Model for Brazil

Observed Variables	λ	Latent Variables	Measurement Error
Favhobby	0.81 (λ_x)	ATTREAD	0.35 (δ)
Feelhapp	0.81 (λ_x)		0.35 (δ)
Enjoylib	0.82 (λ_x)		0.33 (δ)
Talkbook	0.81 (λ_x)		0.35 (δ)
Rehaveto	-0.55 (λ_x)		0.69 (δ)
Fewminut	-0.54 (λ_x)		0.71 (δ)
Wastetim	-0.59 (λ_x)		0.66 (δ)
Schoolib	0.31 (λ_x)		-
Listenme	0.72 (λ_x)	RELATION	0.48 (δ)
Interest	0.70 (λ_x)		0.51 (δ)
Extrhelp	0.73 (λ_x)		0.47 (δ)
Treafair	0.75 (λ_x)		0.43 (δ)
Wellstud	0.56 (λ_x)		0.69 (δ)
Noise	0.85 (λ_x)	CLIMATE	0.27 (δ)
Nothing	0.71 (λ_x)		0.50 (δ)
Notstart	0.62 (λ_x)		0.62 (δ)
Nolisten	0.45 (λ_x)		0.80 (δ)
Longtime	0.64 (λ_x)		0.60 (δ)
Noworkwe	0.37 (λ_x)		0.86 (δ)

Table 4.18 (Continued)

Justtalk	0.71 (λ_x)	COM	0.49 (δ)
Discussb	0.69 (λ_x)		0.53 (δ)
Discussp	0.69 (λ_x)		0.52 (δ)
Mainmeal	0.62 (λ_x)		0.62 (δ)
Usecompu	0.64 (λ_x)	USAGE	0.59 (δ)
Calculat	0.49 (λ_x)		0.76 (δ)
Schoolib	0.36 (λ_x)		0.77 (δ)
Mdonewel	0.83 (λ_y)	ATTMATH	0.32 (ε)
Mgoodmar	0.82 (λ_y)		0.33 (ε)
Mathbest	0.92 (λ_y)		0.16 (ε)
Mathfun	0.80 (λ_y)		0.37 (ε)
Mathimpo	0.53 (λ_y)		0.71 (ε)
Mabsorbe	0.54 (λ_y)		0.71 (ε)
Pv1math	0.91 (λ_y)	MATHLIT	0.17 (ε)
Pv2math	0.92 (λ_y)		0.15 (ε)
Pv3math	0.92 (λ_y)		0.15 (ε)
Pv4math	0.92 (λ_y)		0.15 (ε)
Pv5math	0.91 (λ_y)		0.16 (ε)
Pv1read	0.95 (λ_y)	READLIT	0.10 (ε)
Pv2read	0.95 (λ_y)		0.10 (ε)
Pv3read	0.95 (λ_y)		0.09 (ε)
Pv4read	0.95 (λ_y)		0.10 (ε)
Pv5read	0.95 (λ_y)		0.10 (ε)

As the structure coefficients were defined before in Chapter 3, the γ (lowercase gamma) values indicate the strength and direction of the relationship among the latent dependent and latent independent variables. In addition, the β (lowercase beta) values indicate the strength and direction of the relationship among the latent dependent variables. All the structure coefficients for the mathematical literacy model for Brazil were displayed in standardized values in Table 4.19 and Table 4.20.

Table 4.19 Structure Coefficients of Mathematical Literacy Model for Brazil

Latent Independent Variables	γ	Latent Dependent Variables
ATTREAD	-0.09	MATHLIT
CLIMATE	0.04	
USAGE	0.11	
ATTREAD	0.08	READLIT
RELATION	-0.09	
CLIMATE	0.09	
COM	0.22	
USAGE	0.25	

Table 4.20 Structure Coefficients of Mathematical Literacy Model for Brazil

Latent Dependent Variables	β	Latent Dependent Variables
MATHLIT	0.07	ATTMATH
ATTMATH	0.09	MATHLIT
READLIT	0.83	

The squared multiple correlation (R^2) was also obtained for each variable in LISREL. As known, the R^2 gives the proportion of the explained variance. For instance, values of R^2 equals to 0.50 mean that the 50% of the variance of a variable is explained by another variable. Table 4.21 and Table 4.22 displayed the squared multiple correlations (R^2) of the observed variables which was calculated for each observed variable.

Table 4.21 Squared Multiple Correlations of Observed Variables for Mathematical Literacy Model for Brazil

Variable	R^2	Variable	R^2	Variable	R^2
Favhobby	0.65	Extrhelp	0.53	Noworkwe	0.14
Feelhapp	0.65	Treafair	0.57	Justtalk	0.51
Enjoylib	0.67	Wellstud	0.31	Discussb	0.47
Talkbook	0.65	Noise	0.73	Discussp	0.48
Rehaveto	0.31	Nothing	0.50	Mainmeal	0.38
Fewminut	0.29	Notstart	0.38	Usecompu	0.41
Wastetim	0.34	Nolisten	0.20	Calculat	0.24
Listenme	0.52	Longtime	0.40	Schoolib	0.23
Interest	0.49				

Table 4.22 Squared Multiple Correlations of Observed Variables for Mathematical Literacy Model for Brazil

Variable	R^2	Variable	R^2	Variable	R^2
Mdonewel	0.68	Pv1math	0.83	Pv1read	0.90
Mgoodmar	0.67	Pv2math	0.85	Pv2read	0.90
Mathbest	0.84	Pv3math	0.85	Pv3read	0.91
Mathfun	0.63	Pv4math	0.85	Pv4read	0.90
Mathimpo	0.29	Pv5math	0.84	Pv5read	0.90
Mabsorbe	0.29				

The Mathematical Literacy Model for Brazil was evaluated in accordance with the goodness-of-fit indices. The information about the goodness-of-fit indices was previously presented in Chapter 3. The values of the goodness-of-fit criteria of the model of Brazil can be found in the Appendix D. The Chi-Square, χ^2 = 2678.78, was significant with degrees of freedom, df = 742, and the significance level, p = 0.000. But, the χ^2 criterion is known to have a tendency to indicate a significant probability level when the sample size increases, generally above 200 (Schumacker & Lomax, 1996). The sample size for Brazil was 1 682 students, therefore, a significant test statistic was obtained with this large sample. In addition, the Normed Chi-Square (NC), which is calculated by χ^2 /df, of the model for Brazil was 3.61 which was less than 5 indicating a good fit to the data.

The Goodness-of-Fit Index (GFI) and the Adjusted Goodness-of-Fit Index (AGFI) of the model for Brazil were 0.93 and 0.92, respectively. Since these values were approaching to unity, the model had a good fit to the data.

The Root-Mean-Square Residual (RMR) of the model was 0.071. The value of RMR did not indicate a good fit to the data since the value was greater than 0.05. The Root-Mean-Squared Error of Approximation (RMSEA) of the model was 0.039 indicating a good fit to the data. RMSEA of the model was also in the 90 percent confidence interval for RMSEA which was from 0.038 to 0.041.

The Normed Fit Index (NFI) and the Non-Normed Fit Index (NNFI) of the model were 0.95 and 0.96, respectively. These values were higher than the 0.90 cutoff indicating a good fit to the data.

The Comparative Fit Index (CFI), Incremental Fit Index (IFI) and Relative Fit Index (RFI) of the model for Brazil were 0.96, 0.96 and 0.94, respectively. Since these values were approaching unity, this indicated a good fit to the data.

The Expected Cross Validation Index (ECVI) of the model was 1.74. The ECVI of the model was contained in the 90 percent confidence interval for ECVI which was from 1.64 to 1.83. As known, the confidence interval for the estimate of ECVI is given by LISREL and also ECVI does not have an upper bound. Since the ECVI value of the model was between the values of the confidence interval, it could be said that the model indicated a good fit to the data.

The Parsimonious Normed Fit Index (PNFI) and Parsimonious Goodness-of-Fit Index (PGFI) of the model were 0.86 and 0.80, respectively. As known, higher values of PNFI and PGFI indicate a more parsimonious fit, but 0.90 cutoff is not expected to be obtained for these indices. The values of PNFI and PGFI of the model were quite high values indicating a parsimonious fit of the model.

As a result, all the goodness-of-fit indices of the model were investigated through their criteria and it was found that the model for Brazil indicated a parsimonious fit and a good fit to the data. Thus, all the indicators except for RMR suggested an overall fit between the model and the observed data.

As can be seen from the Figure 4.1, five of the eight attitudinal variables were significantly and positively loaded on ATTREAD, favhobby ($\lambda_x = 0.81$, $p < 0.05$), feelhapp ($\lambda_x = 0.81$, $p < 0.05$), enjoylib ($\lambda_x = 0.82$, $p < 0.05$), talkbook ($\lambda_x = 0.81$, $p < 0.05$) and schoolib ($\lambda_x = 0.31$, $p < 0.05$). Contrast to these variables, the other three attitudinal variables were significantly but negatively loaded on ATTREAD, rehaveto ($\lambda_x = -0.55$, $p < 0.05$), fewminut ($\lambda_x = -0.54$, $p < 0.05$) and wastetim ($\lambda_x = -0.59$, $p < 0.05$). One of the eight variables, enjoylib accounted for the greatest variance ($R^2 = 0.67$) of the latent independent variable ATTREAD.

All the five observed variables were positively and significantly loaded on RELATION, listenme ($\lambda_x = 0.72$, $p < 0.05$), interest ($\lambda_x = 0.70$, $p < 0.05$), extrhelp ($\lambda_x = 0.73$, $p < 0.05$), treafair ($\lambda_x = 0.75$, $p < 0.05$) and wellstud ($\lambda_x = 0.56$, $p < 0.05$). One of the five variables, treafair accounted for the greatest variance ($R^2 = 0.57$) of the latent independent variable RELATION.

All the six observed variables were significantly and positively loaded on CLIMATE, noise (λ_x = 0.85, $p < 0.05$), nothing (λ_x = 0.71, $p < 0.05$), notstart (λ_x = 0.62, $p < 0.05$), nolisten (λ_x = 0.45, $p < 0.05$), longtime (λ_x = 0.64, $p < 0.05$) and noworkwe (λ_x = 0.37, $p < 0.05$). One of the observed variables, noise accounted for the greatest variance (R^2 =0.73) of latent independent variable CLIMATE.

All the four observed variables were significantly and positively loaded on COM, justtalk (λ_x = 0.71, $p < 0.05$), discussb (λ_x = 0.69, $p < 0.05$), discussp (λ_x = 0.69, $p < 0.05$) and mainmeal (λ_x = 0.62, $p < 0.05$). The observed variable, justtalk accounted for the greatest variance (R^2 =0.51) of latent independent variable COM.

The three observed variables were also significantly and positively loaded on USAGE, usecompu (λ_x = 0.64, $p < 0.05$), calculat (λ_x = 0.49, $p < 0.05$) and schoolib (λ_x = 0.36, $p < 0.05$). The observed variable, usecompu accounted for the greatest variance (R^2 =0.41) of latent independent variable USAGE.

Based on the Figure 4.1, the predicted latent variables, ATTMATH, READLIT and MATHLIT were confirmed and that furthermore they were found to account for the observed variances and covariances of the manifest variables. All the six attitudinal variables were positively and significantly loaded on ATTMATH, mdonewel (λ_y = 0.83, $p < 0.05$), mgoodmar (λ_y = 0.82, $p < 0.05$), mathbest (λ_y = 0.92, $p < 0.05$), mathfun (λ_y = 0.80, $p < 0.05$), mathimpo (λ_y = 0.53, $p < 0.05$) and mabsorbe (λ_y = 0.54, $p < 0.05$). Of the six variables, mathbest accounted for the greatest variance (R^2 =0.84) of latent dependent variable ATTMATH.

All the five plausible values for reading scores were significantly and positively loaded on READLIT with the same coefficients (λ_y = 0.95, $p < 0.05$). Of the five plausible values for reading scores, pv3read accounted for the greatest variance (R^2 =0.91) of latent dependent variable READLIT.

The five plausible values for mathematics scores were positively and significantly loaded on MATHLIT, pv1math (λ_y = 0.91, $p < 0.05$), pv2math (λ_y = 0.92, $p < 0.05$), pv3math (λ_y = 0.92, $p < 0.05$), pv4math (λ_y = 0.92, $p < 0.05$) and pv5math (λ_y = 0.92, $p < 0.05$). Of the five plausible values for mathematics scores, each of the observed variables, pv2math, pv3math and pv4math accounted for the greatest variance (R^2 =0.85) of latent dependent variable MATHLIT.

The results displayed in Figure 4.1 further showed the direct effects of the latent independent variables on the latent dependent variables. All the direct effects of the latent independent variables on the latent dependent variables were given in Table 4.23.

Table 4.23 Direct Effects of Latent Independent Variables on Latent Dependent Variables of Mathematical Literacy Model for Brazil

	ATTREAD	RELATION	CLIMATE	COM	USAGE
ATTMATH	-	-	-	-	-
READLIT	0.08	-0.09	0.09	0.22	0.25
MATHLIT	-0.09	-	0.04	-	0.11

LISREL output of the model also presented the indirect effects and the total effects of latent independent variables on latent dependent variables. The values of the indirect effects and total effects of latent independent variables on latent dependent variables were displayed in Table 4.24 and Table 4.25.

Table 4.24 Indirect Effects of Latent Independent Variables on Latent Dependent Variables of Mathematical Literacy Model for Brazil

	ATTREAD	RELATION	CLIMATE	COM	USAGE
ATTMATH	0.00	0.00	0.01	0.01	0.02
READLIT	-	-	-	-	-
MATHLIT	0.07	-0.07	0.08	0.18	0.21

Table 4.25 Total Effects of Latent Independent Variables on Latent Dependent Variables of Mathematical Literacy Model for Brazil

	ATTREAD	RELATION	CLIMATE	COM	USAGE
ATTMATH	0.00	0.00	0.01	0.01	0.02
READLIT	0.08	-0.09	0.09	0.22	0.25
MATHLIT	-0.02	-0.07	0.12	0.18	0.32

The results displayed in Figure 4.1 further show that ATTREAD had a positive direct effect on READLIT ($\Gamma = 0.08$, $p < 0.05$). RELATION had a negative direct effect on READLIT ($\Gamma = -0.09$, $p < 0.05$). The latent independent variables CLIMATE, COM and USAGE had positive direct effects on READLIT ($\Gamma = 0.09$, $\Gamma = 0.22$ and $\Gamma = 0.25$, $p < 0.05$).

Since the latent independent variables did not have any direct effect on ATTMATH, the indirect effects of latent independent variables on ATTMATH would be investigated. ATTREAD and RELATION had significant indirect effects of 0.00 on ATTMATH. CLIMATE had a positive and significant indirect effect of 0.01 on ATTMATH. COM had a positive and significant indirect effect of 0.01 on ATTMATH. USAGE had a positive and significant indirect effect of 0.02 on ATTMATH.

ATTREAD had a negative direct effect on MATHLIT ($\Gamma = -0.09$, $p < 0.05$). The latent independent variable CLIMATE had a significant and positive direct effect on MATHLIT ($\Gamma = 0.04$, $p < 0.05$). And USAGE had a positive and significant direct effect on MATHLIT ($\Gamma = 0.11$, $p < 0.05$). The latent independent variables also had indirect effects on MATHLIT. The latent independent variable ATTREAD had a positive and significant indirect effect of 0.07 on MATHLIT. RELATION had a negative and significant indirect effect of -0.07 on MATHLIT. CLIMATE had a positive and significant indirect effect of 0.08 on MATHLIT. COM had a positive and significant indirect effect of 0.18 on MATHLIT. USAGE had a positive and significant indirect effect of 0.21 on MATHLIT.

According to the Table 4.25, the total effect of ATTREAD on READLIT was 0.08 indicating a significant and positive effect ($\Gamma = 0.08$, $p < 0.05$). The total effect of RELATION on READLIT was -0.09 indicating a significant, but negative effect ($\Gamma = -0.09$, $p < 0.05$). The total effect of CLIMATE, COM and USAGE on READLIT were 0.09, 0.22 and 0.25, respectively, indicating significant and positive effects ($\Gamma = 0.09$, $\Gamma = 0.22$, $\Gamma = 0.25$, $p < 0.05$).

The total effect of ATTREAD on ATTMATH was 0.00 indicating a significant effect. The total effect of RELATION on ATTMATH was 0.00 indicating a significant effect. The total effects of CLIMATE, COM and USAGE on

ATTMATH were 0.01, 0.01 and 0.02, respectively, indicating significant and positive effects.

The total effect of ATTREAD on MATHLIT was -0.02 indicating a significant, but negative effect. The total effect of RELATION on MATHLIT was -0.07 indicating a significant and negative effect. The total effect of CLIMATE on MATHLIT was 0.12 indicating a significant, positive effect. The total effect of COM on MATHLIT was 0.18 indicating a significant and positive effect. The total effect of USAGE on MATHLIT was 0.32 indicating a significant and positive effect.

Finally, among the latent independent variables, USAGE had the greatest total effect of 0.25 which was significant, positive effect on READLIT (Γ= 0.25, $p < 0.05$). One of the latent independent variables, USAGE had greatest total effect of 0.02 indicating a significant, positive effect on ATTMATH. Among the latent independent variables, USAGE had the greatest total effect of 0.32 which is significant, positive effect on MATHLIT.

The results displayed in Figure 4.1 further showed the direct effects of the latent dependent variables on the latent dependent variables. All the direct effects between the latent dependent variables were given in Table 4.26.

Table 4.26 Direct Effects between Latent Dependent Variables of Mathematical Literacy Model for Brazil

	ATTMATH	READLIT	MATHLIT
ATTMATH	-	-	0.07
READLIT	-	-	-
MATHLIT	0.09	0.83	-

LISREL output of the model also presented the indirect effects and the total effects of latent dependent variables on latent dependent variables. The values of the indirect effects and total effects between the latent dependent variables were displayed in Table 4.27 and Table 4.28.

Table 4.27 Indirect Effects between Latent Dependent Variables of Mathematical Literacy Model for Brazil

	ATTMATH	READLIT	MATHLIT
ATTMATH	0.01	0.06	0.00
READLIT	-	-	-
MATHLIT	0.00	0.00	0.01

Table 4.28 Total Effects between Latent Independent Variables of Mathematical Literacy Model for Brazil

	ATTMATH	READLIT	MATHLIT
ATTMATH	0.01	0.06	0.07
READLIT	-	-	-
MATHLIT	0.09	0.83	0.01

The latent dependent variables did not have any effects on the latent dependent variable READLIT. The latent dependent variables had direct and indirect effects on ATTMATH. The latent dependent variable READLIT had a positive and significant indirect effect of 0.06 on ATTMATH. The latent dependent variable MATHLIT had also a positive and significant direct effect of 0.07 on ATTMATH (β= 0.07, $p < 0.05$) and a significant indirect effect of 0.00 on ATTMATH. Moreover, ATTMATH had a significant indirect effect of 0.01 to itself.

Furthermore, the latent dependent variables had direct and indirect effects on MATHLIT. The latent dependent variable ATTMATH had a positive and significant direct effect of 0.09 on MATHLIT ($\beta = 0.09$, $p < 0.05$) and also a significant indirect effect of 0.00 on MATHLIT. READLIT had a positive and significant direct effect of 0.83 on MATHLIT ($\beta = 0.83$, $p < 0.05$). READLIT also had a significant indirect effect of 0.00 on MATHLIT. Lastly, MATHLIT had a significant indirect effect of 0.01 to itself.

The total effect of latent dependent variable READLIT on ATTMATH was 0.06 indicating a significant and positive effect. The total effect of ATTMATH on itself was 0.01 which was significant and positive. Finally, the total effect of

MATHLIT on ATTMATH was 0.07 indicating a positive and significant effect ($\beta = 0.07$, $p < 0.05$).

The total effect of latent dependent variable READLIT on MATHLIT was 0.83 indicating a significant and positive effect ($\beta = 0.83$, $p < 0.05$). The total effect of ATTMATH on MATHLIT was 0.09 indicating a positive and significant effect ($\beta = 0.09$, $p < 0.05$). And lastly, the total effect of MATHLIT on itself was 0.01 which was significant and positive.

The latent dependent variable, MATHLIT had the greatest total effect of 0.07 which was significant, positive effect on ATTMATH ($\beta = 0.07$, $p < 0.05$). Among the latent dependent variables, READLIT had a significant, positive and direct effect on MATHLIT ($\beta = 0.83$, $p < 0.05$). As predicted, reciprocal relationship between ATTMATH and MATHLIT is found. The parameter estimates in Figure 4.1 showed that ATTMATH positively effect MATHLIT ($\beta = 0.09$, $p < 0.05$) and at the same time, MATHLIT had a positive effect on ATTMATH ($\beta = 0.07$, $p < 0.05$). Reciprocal effects that ATTMATH and MATHLIT have between each other were different in magnitude. A conclusion about the reciprocal effects of ATTMATH and MATHLIT could be made as ATTMATH had a stronger effect on MATHLIT in the mathematical literacy model for Brazil.

4.2.2 The Mathematical Literacy Model for Japan

At the beginning, the actual model presented in Chapter 1 was tested with Japan data. Afterwards, the path from the latent variable, ATTREAD, to the observed variable, SCHOOLIB, was constructed on the basis of the modification index. Later on, twelve covariance terms were added to the SIMPLIS syntax in order to improve the model considering the highest meaningful modification indices. The final SIMPLIS syntax for Mathematics Literacy Model for Japan can be found in the second section of the Appendix B. LISREL estimates of parameters in structural model of Japan in which the coefficients were in standardized values was presented in Figure 4.3. Moreover, the Figure 4.4 displayed LISREL estimates of parameters in structural model of Japan in which the coefficients were in t-values. Besides, LISREL estimates of parameters in measurement model of Japan with coefficients in standardized value and t-values can be found in the second part of Appendix C.

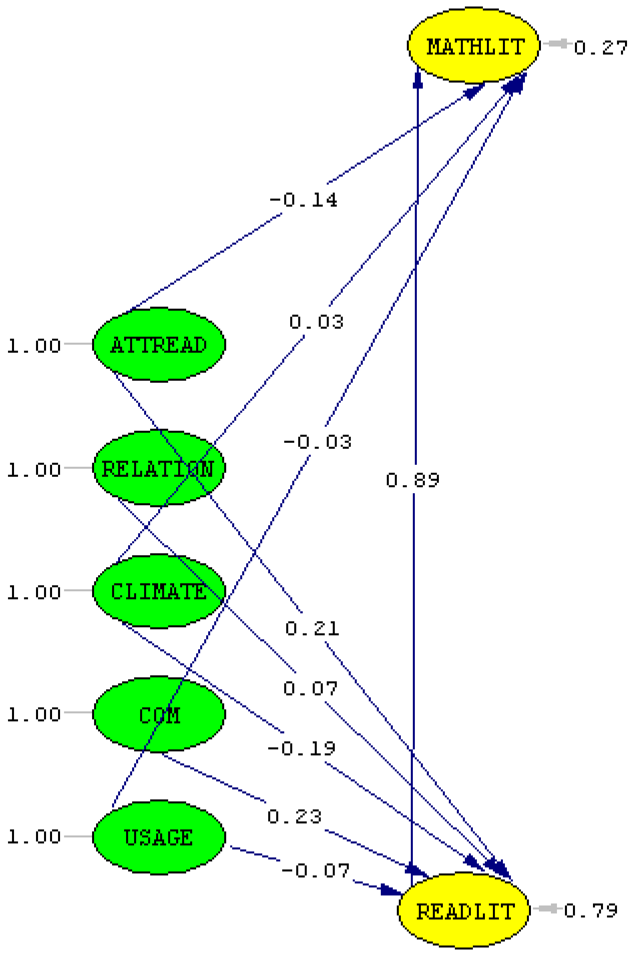

Figure 4.3 LISREL Estimates of Parameters in Structural Model of Japan (Coefficients in Standardized Value)

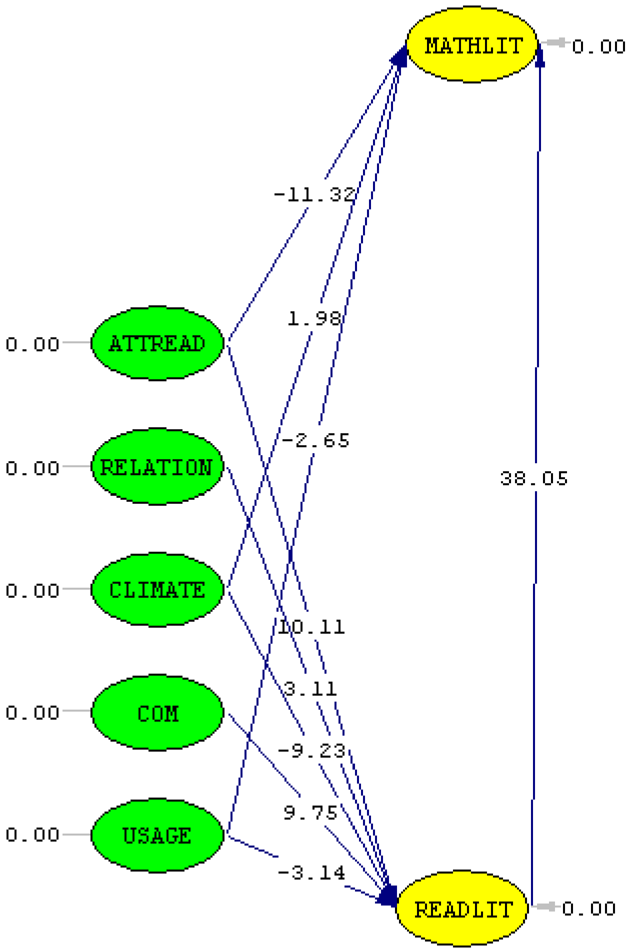

Figure 4.4 LISREL Estimates of Parameters in Structural Model of Japan (Coefficients in t-Values)

As can be seen easily from the Figure 4.3, the structural equation model was consisted of five latent independent variables and two latent dependent variables. The latent independent variables were Attitudes towards Reading (ATTREAD), Student-Teacher Relations (RELATION), Climate (CLIMATE), Communication with Parents (COM) and Usage of Technology and Facilities (USAGE) while the latent dependent variables were Mathematical Literacy (MATHLIT) and Reading Literacy (READLIT). The five plausible values of Math scores from Pv1math to Pv5math were the observed variables of the latent dependent variable MATHLIT. Finally, the latent dependent variable READLIT was consisted of the five plausible values of Reading scores from Pv1read to Pv5read. Different from the mathematical literacy model for Brazil, the mathematical literacy model for Japan did not include the latent dependent variable ATTMATH. Since the cross-curricular competencies questionnaire was an optional questionnaire and the questionnaire was not administered in Japan, there was not any data for the variable ATTMATH in Japan. Consequently, the mathematical literacy model for Japan did not contain the latent dependent variable ATTMATH.

Since the measurement coefficients were defined before in Chapter 3, the λ_y (lowercase lambda sub y) and the λ_x (lowercase lambda sub x) values indicate the relationships between the latent variables and the observed variables. Moreover, the ε (lowercase epsilon) and δ (lowercase delta) are the measurement errors for the Ys and Xs, respectively. All these measurement coefficients for mathematical literacy model for Japan were given in standardized values in Table 4.29.

Table 4.29 Measurement Coefficients of Mathematical Literacy Model for Japan

Observed Variables	λ	Latent Variables	Measurement Error
Favhobby	0.92 (λ_x)	ATTREAD	0.15 (δ)
Feelhapp	0.74 (λ_x)		0.45 (δ)
Enjoylib	0.63 (λ_x)		0.60 (δ)
Talkbook	0.73 (λ_x)		0.46 (δ)
Rehaveto	-0.79 (λ_x)		0.37 (δ)
Fewminut	-0.67 (λ_x)		0.55 (δ)
Wastetim	-0.70 (λ_x)		0.51 (δ)
Schoolib	0.40 (λ_x)		-
Listenme	0.87 (λ_x)	RELATION	0.24 (δ)
Interest	0.84 (λ_x)		0.29 (δ)
Extrhelp	0.79 (λ_x)		0.38 (δ)
Treafair	0.69 (λ_x)		0.53 (δ)
Wellstud	0.70 (λ_x)		0.51 (δ)
Noise	0.84 (λ_x)	CLIMATE	0.29 (δ)
Nothing	0.76 (λ_x)		0.42 (δ)
Notstart	0.81 (λ_x)		0.35 (δ)
Nolisten	0.72 (λ_x)		0.48 (δ)
Longtime	0.53 (λ_x)		0.72 (δ)
Noworkwe	0.40 (λ_x)		0.84 (δ)

Table 4.29 (Continued)

Justtalk	0.76 (λ_x)	COM	0.42 (δ)
Discussb	0.71 (λ_x)		0.50 (δ)
Discussp	0.70 (λ_x)		0.51 (δ)
Mainmeal	0.48 (λ_x)		0.77 (δ)
Usecompu	0.78 (λ_x)	USAGE	0.40 (δ)
Calculat	0.77 (λ_x)		0.41 (δ)
Schoolib	0.21 (λ_x)		0.79 (δ)
Pv1math	0.93 (λ_y)	MATHLIT	0.13 (ε)
Pv2math	0.93 (λ_y)		0.14 (ε)
Pv3math	0.93 (λ_y)		0.13 (ε)
Pv4math	0.93 (λ_y)		0.14 (ε)
Pv5math	0.93 (λ_y)		0.14 (ε)
Pv1read	0.95 (λ_y)	READLIT	0.10 (ε)
Pv2read	0.95 (λ_y)		0.09 (ε)
Pv3read	0.95 (λ_y)		0.10 (ε)
Pv4read	0.95 (λ_y)		0.09 (ε)
Pv5read	0.95 (λ_y)		0.10 (ε)

As the structure coefficients were defined before in Chapter 3, the γ (lowercase gamma) values indicate the strength and direction of the relationship among the latent dependent and latent independent variables. In addition, the β (lowercase beta) values indicate the strength and direction of the relationship among the latent dependent variables. All the structure coefficients for the mathematical literacy model for Japan were displayed in standardized values in Table 4.30 and Table 4.31.

Table 4.30 Structure Coefficients of Mathematical Literacy Model for Japan

Latent Independent Variables	γ	Latent Dependent Variables
ATTREAD	-0.14	MATHLIT
CLIMATE	0.03	
USAGE	-0.03	
ATTREAD	0.21	READLIT
RELATION	0.07	
CLIMATE	-0.19	
COM	0.23	
USAGE	-0.07	

Table 4.31 Structure Coefficients of Mathematical Literacy Model for Japan

Latent Dependent Variables	β	Latent Dependent Variables
READLIT	0.89	MATHLIT

The squared multiple correlation (R^2) was also obtained for each variable in LISREL. As known, the R^2 gives the proportion of the explained variance. For instance, values of R^2 equals to 0.50 mean that the 50% of the variance of a variable is explained by another variable. Table 4.32 and Table 4.33 displayed the squared multiple correlations (R^2) of the observed variables which was calculated for each observed variable.

Table 4.32 Squared Multiple Correlations of Observed Variables for Mathematical Literacy Model for Japan

Variable	R^2	Variable	R^2	Variable	R^2
Favhobby	0.85	Extrhelp	0.62	Noworkwe	0.16
Feelhapp	0.55	Treafair	0.47	Justtalk	0.58
Enjoylib	0.40	Wellstud	0.49	Discussb	0.50
Talkbook	0.54	Noise	0.71	Discussp	0.49
Rehaveto	0.63	Nothing	0.58	Mainmeal	0.23
Fewminut	0.45	Notstart	0.65	Usecompu	0.60
Wastetim	0.49	Nolisten	0.52	Calculat	0.59
Listenme	0.76	Longtime	0.28	Schoolib	0.21
Interest	0.71				

Table 4.33 Squared Multiple Correlations of Observed Variables for Mathematical Literacy Model for Japan

Variable	R^2	Variable	R^2	Variable	R^2
Pv1math	0.87	Pv5math	0.86	Pv3read	0.90
Pv2math	0.86	Pv1read	0.90	Pv4read	0.91
Pv3math	0.87	Pv2read	0.91	Pv5read	0.90
Pv4math	0.86				

The Mathematical Literacy Model for Japan was evaluated in accordance with the goodness-of-fit indices. The information about the goodness-of-fit indices was previously presented in Chapter 3. The values of the goodness-of-fit criteria of the model of Japan can be found in the Appendix D. The Chi-Square, χ^2 = 2514.77, was significant with degrees of freedom, df = 528, and the significance level, p = 0.000. But, the χ^2 criterion is known to have a tendency to indicate a significant probability level when the sample size increases, generally above 200 (Schumacker & Lomax, 1996). The sample size for Japan was 2 476 students, therefore, a significant test statistic was obtained with this large sample. In addition, the Normed Chi-Square (NC), which is calculated by χ^2 /df, of the model for Japan was 4.76 which was less than 5 indicating a good fit to the data.

The Goodness-of-Fit Index (GFI) and the Adjusted Goodness-of-Fit Index (AGFI) of the model for Brazil were 0.95 and 0.93, respectively. Since these values were approaching to unity, the model had a good fit to the data.

The Root-Mean-Square Residual (RMR) of the model was 0.046. The value of RMR indicated a good fit to the data since the value was less than 0.05. The Root-Mean-Squared Error of Approximation (RMSEA) of the model was 0.039 indicating a good fit to the data. RMSEA of the model was also in the 90 percent confidence interval for RMSEA which was from 0.037 to 0.041.

The Normed Fit Index (NFI) and the Non-Normed Fit Index (NNFI) of the model were 0.97 which were equal to each other. These values were higher than the 0.90 cutoff indicating a good fit to the data.

The Comparative Fit Index (CFI), Incremental Fit Index (IFI) and Relative Fit Index (RFI) of the model for Brazil were 0.97, 0.97 and 0.96, respectively. Since these values were approaching unity, this indicated a good fit to the data.

The Expected Cross Validation Index (ECVI) of the model was 1.10. The ECVI of the model was contained in the 90 percent confidence interval for ECVI which was from 1.04 to 1.16. As known, the confidence interval for the estimate of ECVI is given by LISREL and also ECVI does not have an upper bound. Since the ECVI value of the model was between the values of the confidence interval, it could be said that the model indicated a good fit to the data.

The Parsimonious Normed Fit Index (PNFI) and Parsimonious Goodness-of-Fit Index (PGFI) of the model were 0.86 and 0.79, respectively. As known, higher values of PNFI and PGFI indicate a more parsimonious fit, but 0.90 cutoff is not expected to be obtained for these indices. The values of PNFI and PGFI of the model were quite high values indicating a parsimonious fit of the model.

As a result, all the goodness-of-fit indices of the model were investigated through their criteria and it was found that the model for Japan indicated a parsimonious fit and a good fit to the data. Thus, all the indicators suggested an overall fit between the model and the observed data.

As can be seen from the Figure 4.3, five of the eight attitudinal variables were significantly and positively loaded on ATTREAD, favhobby (λ_x = 0.92, $p < 0.05$), feelhapp (λ_x = 0.74, $p < 0.05$), enjoylib (λ_x = 0.63, $p < 0.05$), talkbook (λ_x = 0.73, $p < 0.05$) and schoolib (λ_x = 0.40, $p < 0.05$). Contrast to these variables, the other three attitudinal variables were significantly but negatively loaded on ATTREAD, rehaveto (λ_x = -0.79, $p < 0.05$), fewminut (λ_x = -0.67, $p < 0.05$) and wastetim (λ_x = -0.70, $p < 0.05$). One of the eight variables, favhobby accounted for the greatest variance (R^2 =0.85) of the latent independent variable ATTREAD.

All the five observed variables were positively and significantly loaded on RELATION, listenme (λ_x = 0.87, $p < 0.05$), interest (λ_x = 0.84, $p < 0.05$), extrhelp (λ_x = 0.79, $p < 0.05$), treafair (λ_x = 0.69, $p < 0.05$) and wellstud (λ_x = 0.70, $p < 0.05$). One of the five variables, listenme accounted for the greatest variance (R^2 =0.76) of the latent independent variable RELATION.

All the six observed variables were significantly and positively loaded on CLIMATE, noise (λ_x = 0.84, $p < 0.05$), nothing (λ_x = 0.76, $p < 0.05$), notstart (λ_x = 0.81, $p < 0.05$), nolisten (λ_x = 0.72, $p < 0.05$), longtime (λ_x = 0.53, $p < 0.05$) and noworkwe (λ_x = 0.40, $p < 0.05$). One of the observed variables, noise accounted for the greatest variance (R^2 =0.71) of latent independent variable CLIMATE.

All the four observed variables were significantly and positively loaded on COM, justtalk (λ_x = 0.76, $p < 0.05$), discussb (λ_x = 0.71, $p < 0.05$), discussp (λ_x = 0.70, $p < 0.05$) and mainmeal (λ_x = 0.48, $p < 0.05$). The observed variable, justtalk accounted for the greatest variance (R^2 =0.58) of latent independent variable COM.

The three observed variables were also significantly and positively loaded on USAGE, usecompu (λ_x = 0.78, $p < 0.05$), calculat (λ_x = 0.77, $p < 0.05$) and schoolib (λ_x = 0.21, $p < 0.05$). The observed variable, usecompu accounted for the greatest variance (R^2 =0.60) of latent independent variable USAGE.

Based on the Figure 4.3, the predicted latent variables, READLIT and MATHLIT were confirmed and that furthermore they were found to account for the observed variances and covariances of the manifest variables. All the five plausible values for reading scores were significantly and positively loaded on READLIT with the same coefficients (λ_y = 0.95, $p < 0.05$). Of the five plausible values for reading scores, each of the observed variables, pv2read and pv4read accounted for the greatest variance (R^2 =0.91) of latent dependent variable READLIT.

The five plausible values for mathematics scores were positively and significantly loaded on MATHLIT with the same coefficients (λ_y = 0.93, $p < 0.05$). Of the five plausible values for mathematics scores, each of the observed variables, pv1math and pv3math accounted for the greatest variance (R^2 =0.87) of latent dependent variable MATHLIT.

The results displayed in Figure 4.3 further showed the direct effects of the latent independent variables on the latent dependent variables. All the direct effects of the latent independent variables on the latent dependent variables were given in Table 4.34.

Table 4.34 Direct Effects of Latent Independent Variables on Latent Dependent Variables of Mathematical Literacy Model for Japan

	ATTREAD	RELATION	CLIMATE	COM	USAGE
READLIT	0.21	0.07	-0.19	0.23	0.07
MATHLIT	-0.14	-	0.03	-	-0.03

LISREL output of the model also presented the indirect effects and the total effects of latent independent variables on latent dependent variables. The values of the indirect effects and total effects of latent independent variables on latent dependent variables were displayed in Table 4.35 and Table 4.36.

Table 4.35 Indirect Effects of Latent Independent Variables on Latent Dependent Variables of Mathematical Literacy Model for Japan

	ATTREAD	RELATION	CLIMATE	COM	USAGE
READLIT	-	-	-	-	-
MATHLIT	0.19	0.06	-0.17	0.21	-0.06

Table 4.36 Total Effects of Latent Independent Variables on Latent Dependent Variables of Mathematical Literacy Model for Japan

	ATTREAD	RELATION	CLIMATE	COM	USAGE
READLIT	0.21	0.07	-0.19	0.23	-0.07
MATHLIT	0.04	0.06	-0.15	0.21	-0.09

The results displayed in Figure 4.3 further show that ATTREAD had a positive direct effect of 0.21 on READLIT ($\Gamma = 0.21$, $p < 0.05$). RELATION had a positive direct effect of 0.07 on READLIT ($\Gamma = 0.07$, $p < 0.05$). CLIMATE had a negative direct effect of -0.19 on READLIT ($\Gamma = -0.19$, $p < 0.05$). COM had a positive direct effect of 0.23 on READLIT ($\Gamma = 0.23$, $p < 0.05$). The latent independent variable USAGE had negative direct effect of -0.07 on READLIT ($\Gamma = -0.07$, $p < 0.05$).

ATTREAD had a negative direct effect on MATHLIT ($\Gamma = -0.14$, $p < 0.05$). The latent independent variable CLIMATE had a significant and positive direct effect on MATHLIT ($\Gamma = 0.03$, $p < 0.05$). And USAGE had a negative and significant direct effect on MATHLIT ($\Gamma = -0.03$, $p < 0.05$). The latent independent variables also had indirect effects on MATHLIT. The latent independent variable ATTREAD had a positive and significant indirect effect of 0.19 on MATHLIT. RELATION had a positive and significant indirect effect of 0.06 on MATHLIT. CLIMATE had a negative and significant indirect effect of -0.17 on MATHLIT. COM had a positive and significant indirect effect of 0.21 on MATHLIT. USAGE had a negative and significant indirect effect of -0.06 on MATHLIT.

According to the Table 4.36, the total effect of ATTREAD on READLIT was 0.21 indicating a significant, and positive effect ($\Gamma = 0.21$, $p < 0.05$). The total effect of RELATION on READLIT was 0.07 indicating a significant and positive effect ($\Gamma = 0.07$, $p < 0.05$). The total effect of CLIMATE on READLIT was -0.19 indicating a significant and negative effect ($\Gamma = -0.19$, $p < 0.05$). The total effect of COM on READLIT was 0.23 indicating a significant and positive effect ($\Gamma = 0.23$, $p < 0.05$). The total effect of USAGE on READLIT was -0.07 indicating a significant and negative effect ($\Gamma = -0.07$, $p < 0.05$).

The total effect of ATTREAD on MATHLIT was 0.04 indicating a significant and positive effect. The total effect of RELATION on MATHLIT was 0.06 indicating a significant and positive effect. The total effect of CLIMATE on MATHLIT was -0.15 indicating a significant, negative effect. The total effect of COM on MATHLIT was 0.21 indicating a significant and positive effect. The total effect of USAGE on MATHLIT was -0.09 indicating a significant and negative effect.

Finally, among the latent independent variables, COM had the greatest total effect of 0.23 which was significant, positive effect on READLIT ($\Gamma= 0.25$, $p < 0.05$). Among the latent independent variables, COM had the greatest total effect of 0.21 which is significant, positive effect on MATHLIT.

The results displayed in Figure 4.3 further showed the direct effects of the latent dependent variables on the latent dependent variables. LISREL output of the model also presented the indirect effects and the total effects of latent dependent variables on latent dependent variables. Since there was not any indirect effect between the latent dependent variables, the total effects were equal to the direct effects between latent dependent variables. All the total effects between the latent dependent variables were given in Table 4.37.

Table 4.37 Total Effects between Latent Dependent Variables of Mathematical Literacy Model for Japan

	READLIT	MATHLIT
READLIT	-	-
MATHLIT	0.89	-

The latent dependent variable MATHLIT did not have any effect on the latent dependent variable READLIT. The direct effect of latent dependent variable READLIT on MATHLIT was 0.89 indicating a significant and positive effect ($\beta = 0.89$, $p < 0.05$). Since the direct effect of READLIT was equal to the total effect of READLIT on MATHLIT, the total effect of latent dependent variable READLIT on MATHLIT was 0.89 indicating a significant and positive effect ($\beta = 0.89$, $p < 0.05$).

4.2.3 The Mathematical Literacy Model for Norway

At the beginning, the actual model presented in Chapter 1 was tested with Norway data. Afterwards, the path from the latent variable, ATTREAD, to the observed variable, SCHOOLIB, was constructed on the basis of the modification index. Later on, fifteen covariance terms were added to the SIMPLIS syntax in order to improve the model considering the highest meaningful modification indices. The final SIMPLIS syntax for Mathematics Literacy Model for Norway can be found in the third section of the Appendix B. LISREL estimates of parameters in structural model of Norway in which the coefficients were in standardized values was presented in Figure 4.5. Moreover, the Figure 4.6 displayed LISREL estimates of parameters in structural model of Norway in which the coefficients were in t-values. Besides, LISREL estimates of parameters in measurement model of Norway with coefficients in standardized value and t-values can be found in the third part of Appendix C.

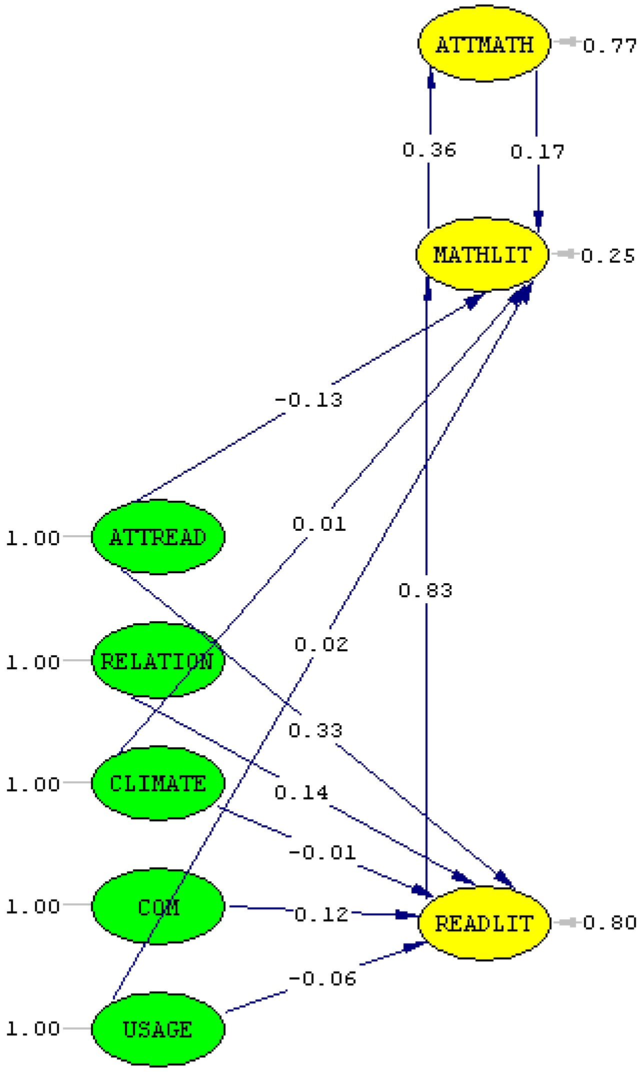

Figure 4.5 LISREL Estimates of Parameters in Structural Model of Norway (Coefficients in Standardized Value)

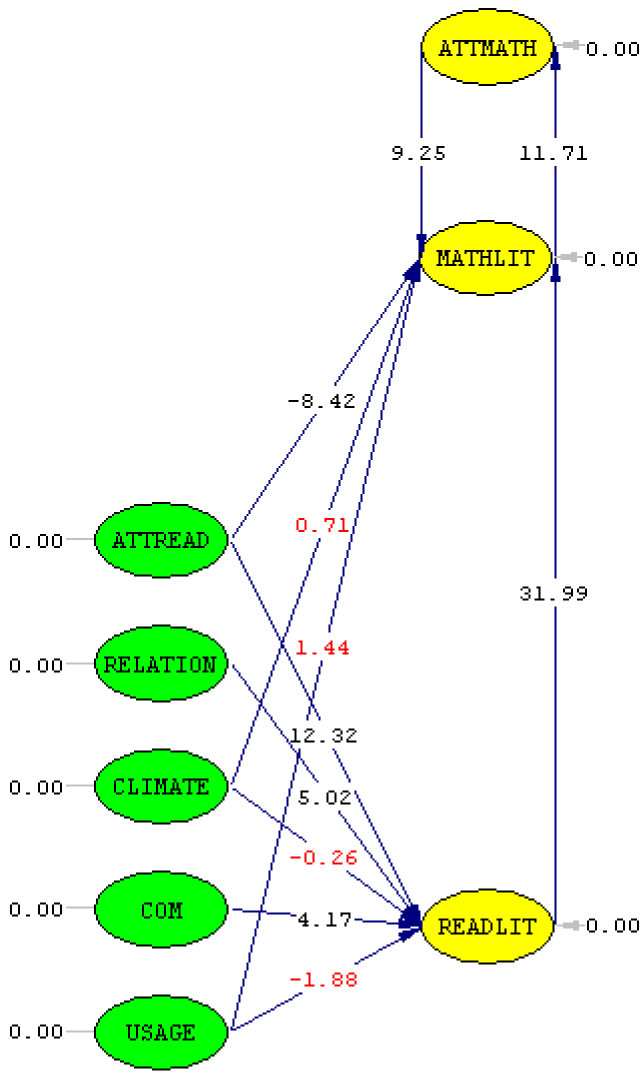

Figure 4.6 LISREL Estimates of Parameters in Structural Model of Norway (Coefficients in t-Values)

As can be seen easily from the Figure 4.5, the structural equation model was consisted of five latent independent variables and three latent dependent variables. The latent independent variables were Attitudes towards Reading (ATTREAD), Student-Teacher Relations (RELATION), Climate (CLIMATE), Communication with Parents (COM) and Usage of Technology and Facilities (USAGE) while the latent dependent variables were Attitudes towards Mathematics (ATTMATH), Mathematical Literacy (MATHLIT) and Reading Literacy (READLIT). Done well (mdonewel), Good marks math (mgoodmar), Math best (mathbest), Math fun (mathfun), Math important (mathimpo) and Math absorbed (mabsorbe) were the observed variables of the latent dependent variable ATTMATH. The five plausible values of Math scores from Pv1math to Pv5math were the observed variables of the latent dependent variable MATHLIT. Finally, the latent dependent variable READLIT was consisted of the five plausible values of Reading scores from Pv1read to Pv5read.

Since the measurement coefficients were defined before in Chapter 3, the λ_y (lowercase lambda sub y) and the λ_x (lowercase lambda sub x) values indicate the relationships between the latent variables and the observed variables. Moreover, the ε (lowercase epsilon) and δ (lowercase delta) are the measurement errors for the Ys and Xs, respectively. All these measurement coefficients for mathematical literacy model for Norway were given in standardized values in Table 4.38.

Table 4.38 Measurement Coefficients of Mathematical Literacy Model for Norway

Observed Variables	λ	Latent Variables	Measurement Error
Favhobby	0.83 (λ_x)	ATTREAD	0.31 (δ)
Feelhapp	0.81 (λ_x)		0.34 (δ)
Enjoylib	0.77 (λ_x)		0.40 (δ)
Talkbook	0.81 (λ_x)		0.34 (δ)
Rehaveto	-0.74 (λ_x)		0.46 (δ)
Fewminut	-0.59 (λ_x)		0.65 (δ)
Wastetim	-0.71 (λ_x)		0.50 (δ)
Schoolib	0.17(λ_x)		-
Listenme	0.84 (λ_x)	RELATION	0.30 (δ)
Interest	0.78 (λ_x)		0.39 (δ)
Extrhelp	0.71 (λ_x)		0.50 (δ)
Treafair	0.69 (λ_x)		0.53 (δ)
Wellstud	0.72 (λ_x)		0.48 (δ)
Noise	0.86 (λ_x)	CLIMATE	0.25 (δ)
Nothing	0.72 (λ_x)		0.48 (δ)
Notstart	0.76 (λ_x)		0.42 (δ)
Nolisten	0.64 (λ_x)		0.59 (δ)
Longtime	0.74 (λ_x)		0.45 (δ)
Noworkwe	0.54 (λ_x)		0.71 (δ)

Table 4.38 (Continued)

Justtalk	0.68 (λ_x)	COM	0.54 (δ)
Discussb	0.56 (λ_x)		0.69 (δ)
Discussp	0.74 (λ_x)		0.45 (δ)
Mainmeal	0.54 (λ_x)		0.71 (δ)
Usecompu	0.63 (λ_x)	USAGE	0.61 (δ)
Calculat	0.21 (λ_x)		0.96 (δ)
Schoolib	0.71 (λ_x)		0.49 (δ)
Mdonewel	0.86 (λ_y)	ATTMATH	0.26 (ε)
Mgoodmar	0.88 (λ_y)		0.22 (ε)
Mathbest	0.95 (λ_y)		0.09 (ε)
Mathfun	0.84 (λ_y)		0.30 (ε)
Mathimpo	0.70 (λ_y)		0.50 (ε)
Mabsorbe	0.62 (λ_y)		0.62 (ε)
Pv1math	0.93 (λ_y)	MATHLIT	0.14 (ε)
Pv2math	0.93 (λ_y)		0.13 (ε)
Pv3math	0.94 (λ_y)		0.13 (ε)
Pv4math	0.93 (λ_y)		0.13 (ε)
Pv5math	0.93 (λ_y)		0.12 (ε)
Pv1read	0.96 (λ_y)	READLIT	0.08 (ε)
Pv2read	0.96 (λ_y)		0.08 (ε)
Pv3read	0.96 (λ_y)		0.08 (ε)
Pv4read	0.96 (λ_y)		0.08 (ε)
Pv5read	0.96 (λ_y)		0.08 (ε)

As the structure coefficients were defined before in Chapter 3, the γ (lowercase gamma) values indicate the strength and direction of the relationship among the latent dependent and latent independent variables. In addition, the β (lowercase beta) values indicate the strength and direction of the relationship among the latent dependent variables. All the structure coefficients for the mathematical literacy model for Norway were displayed in standardized values in Table 4.39 and Table 4.40.

Table 4.39 Structure Coefficients of Mathematical Literacy Model for Norway

Latent Independent Variables	γ	Latent Dependent Variables
ATTREAD	-0.13	MATHLIT
CLIMATE	0.01	
USAGE	0.02	
ATTREAD	0.33	READLIT
RELATION	0.14	
CLIMATE	-0.01	
COM	0.12	
USAGE	-0.06	

Table 4.40 Structure Coefficients of Mathematical Literacy Model for Norway

Latent Dependent Variables	β	Latent Dependent Variables
MATHLIT	0.36	ATTMATH
ATTMATH	0.17	MATHLIT
READLIT	0.83	

The squared multiple correlation (R^2) was also obtained for each variable in LISREL. As known, the R^2 gives the proportion of the explained variance. For instance, values of R^2 equals to 0.50 mean that the 50% of the variance of a variable is explained by another variable. Table 4.41 and Table 4.42 displayed the squared multiple correlations (R^2) of the observed variables which was calculated for each observed variable.

Table 4.41 Squared Multiple Correlations of Observed Variables for Mathematical Literacy Model for Norway

Variable	R^2	Variable	R^2	Variable	R^2
Favhobby	0.69	Extrhelp	0.50	Noworkwe	0.29
Feelhapp	0.66	Treafair	0.47	Justtalk	0.46
Enjoylib	0.60	Wellstud	0.52	Discussb	0.31
Talkbook	0.66	Noise	0.75	Discussp	0.55
Rehaveto	0.54	Nothing	0.52	Mainmeal	0.29
Fewminut	0.35	Notstart	0.58	Usecompu	0.39
Wastetim	0.50	Nolisten	0.41	Calculat	0.04
Listenme	0.70	Longtime	0.55	Schoolib	0.51
Interest	0.61				

Table 4.42 Squared Multiple Correlations of the Observed Variables for Mathematical Literacy Model for Norway

Variable	R^2	Variable	R^2	Variable	R^2
Mdonewel	0.74	Pv1math	0.86	Pv1read	0.92
Mgoodmar	0.78	Pv2math	0.87	Pv2read	0.92
Mathbest	0.91	Pv3math	0.87	Pv3read	0.92
Mathfun	0.70	Pv4math	0.87	Pv4read	0.92
Mathimpo	0.50	Pv5math	0.88	Pv5read	0.92
Mabsorbe	0.38				

The Mathematical Literacy Model for Norway was evaluated in accordance with the goodness-of-fit indices. The information about the goodness-of-fit indices was previously presented in Chapter 3. The values of the goodness-of-fit criteria of the model of Norway can be found in the Appendix D. The Chi-Square, χ^2 = 3610.44, was significant with degrees of freedom, df = 742, and the significance level, p = 0.000. But, the χ^2 criterion is known to have a tendency to indicate a significant probability level when the sample size increases, generally above 200 (Schumacker & Lomax, 1996). The sample size for Norway was 1 770 students, therefore, a significant test statistic was obtained with this large sample. In addition, the Normed Chi-Square (NC), which is calculated by χ^2/df, of the model for Norway was 4.87 which was less than 5 indicating a good fit to the data.

The Goodness-of-Fit Index (GFI) and the Adjusted Goodness-of-Fit Index (AGFI) of the model for Norway were 0.91 and 0.89, respectively. Since these values were approaching to unity, the model had a good fit to the data.

The Root-Mean-Square Residual (RMR) of the model was 0.068. The value of RMR did not indicate a good fit to the data since the value was greater than 0.05. The Root-Mean-Squared Error of Approximation (RMSEA) of the model was 0.047 indicating a good fit to the data. RMSEA of the model was also in the 90 percent confidence interval for RMSEA which was from 0.045 to 0.048.

The Normed Fit Index (NFI) and the Non-Normed Fit Index (NNFI) of the model were 0.94 and 0.95, respectively. These values were higher than the 0.90 cutoff indicating a good fit to the data.

The Comparative Fit Index (CFI), Incremental Fit Index (IFI) and Relative Fit Index (RFI) of the model for Norway were 0.95, 0.95 and 0.94, respectively. Since these values were approaching unity, this indicated a good fit to the data.

The Expected Cross Validation Index (ECVI) of the model was 2.18. The ECVI of the model was contained in the 90 percent confidence interval for ECVI which was from 2.07 to 2.28. As known, the confidence interval for the estimate of ECVI is given by LISREL and also ECVI does not have an upper bound. Since the ECVI value of the model was between the values of the confidence interval, it could be said that the model indicated a good fit to the data.

The Parsimonious Normed Fit Index (PNFI) and Parsimonious Goodness-of-Fit Index (PGFI) of the model were 0.85 and 0.78, respectively. As known, higher values of PNFI and PGFI indicate a more parsimonious fit, but 0.90 cutoff is not expected to be obtained for these indices. The values of PNFI and PGFI of the model were quite high values indicating a parsimonious fit of the model.

As a result, all the goodness-of-fit indices of the model were investigated through their criteria and it was found that the model for Norway indicated a parsimonious fit and a good fit to the data. Thus, all the indicators except for RMR suggested an overall fit between the model and the observed data.

As can be seen from the Figure 4.5, five of the eight attitudinal variables were significantly and positively loaded on ATTREAD, favhobby ($\lambda_x = 0.83$, $p < 0.05$), feelhapp ($\lambda_x = 0.81$, $p < 0.05$), enjoylib ($\lambda_x = 0.77$, $p < 0.05$), talkbook ($\lambda_x = 0.81$, $p < 0.05$) and schoolib ($\lambda_x = 0.17$, $p < 0.05$). Contrast to these variables, the other three attitudinal variables were significantly but negatively loaded on ATTREAD, rehaveto ($\lambda_x = -0.74$, $p < 0.05$), fewminut ($\lambda_x = -0.59$, $p < 0.05$) and wastetim ($\lambda_x = -0.71$, $p < 0.05$). One of the eight variables, favhobby accounted for the greatest variance ($R^2 = 0.69$) of the latent independent variable ATTREAD.

All the five observed variables were positively and significantly loaded on RELATION, listenme ($\lambda_x = 0.84$, $p < 0.05$), interest ($\lambda_x = 0.78$, $p < 0.05$), extrhelp ($\lambda_x = 0.71$, $p < 0.05$), treafair ($\lambda_x = 0.69$, $p < 0.05$) and wellstud ($\lambda_x = 0.72$, $p < 0.05$). One of the five variables, listenme accounted for the greatest variance ($R^2 = 0.70$) of the latent independent variable RELATION.

All the six observed variables were significantly and positively loaded on CLIMATE, noise (λ_x = 0.86, $p < 0.05$), nothing (λ_x = 0.72, $p < 0.05$), notstart (λ_x = 0.76, $p < 0.05$), nolisten (λ_x = 0.64, $p < 0.05$), longtime (λ_x = 0.74, $p < 0.05$) and noworkwe (λ_x = 0.54, $p < 0.05$). One of the observed variables, noise accounted for the greatest variance (R^2 =0.75) of latent independent variable CLIMATE.

All the four observed variables were significantly and positively loaded on COM, justtalk (λ_x = 0.68, $p < 0.05$), discussb (λ_x = 0.56, $p < 0.05$), discussp (λ_x = 0.74, $p < 0.05$) and mainmeal (λ_x = 0.54, $p < 0.05$). The observed variable, discussp accounted for the greatest variance (R^2 =0.55) of latent independent variable COM.

The three observed variables were also significantly and positively loaded on USAGE, usecompu (λ_x = 0.63, $p < 0.05$), calculat (λ_x = 0.21, $p < 0.05$) and schoolib (λ_x = 0.71, $p < 0.05$). The observed variable, schoolib accounted for the greatest variance (R^2 =0.51) of latent independent variable USAGE.

Based on the Figure 4.5, the predicted latent variables, ATTMATH, READLIT and MATHLIT were confirmed and that furthermore they were found to account for the observed variances and covariances of the manifest variables. All the six attitudinal variables were positively and significantly loaded on ATTMATH, mdonewel (λ_y = 0.86, $p < 0.05$), mgoodmar (λ_y = 0.88, $p < 0.05$), mathbest (λ_y = 0.95, $p < 0.05$), mathfun (λ_y = 0.84, $p < 0.05$), mathimpo (λ_y = 0.70, $p < 0.05$) and mabsorbe (λ_y = 0.62, $p < 0.05$). Of the six variables, mathbest accounted for the greatest variance (R^2 =0.91) of latent dependent variable ATTMATH.

All the five plausible values for reading scores were significantly and positively loaded on READLIT with the same coefficients (λ_y = 0.96, $p < 0.05$). Each of the five plausible values for reading scores accounted separately for the greatest variance (R^2 =0.92) of latent dependent variable READLIT.

The five plausible values for mathematics scores were positively and significantly loaded on MATHLIT, pv1math (λ_y = 0.93, $p < 0.05$), pv2math (λ_y = 0.93, $p < 0.05$), pv3math (λ_y = 0.94, $p < 0.05$), pv4math (λ_y = 0.93, $p < 0.05$) and pv5math (λ_y = 0.93, $p < 0.05$). Of the five plausible values for mathematics scores, pv5math accounted for the greatest variance (R^2 =0.88) of latent dependent variable MATHLIT.

The results displayed in Figure 4.5 further showed the direct effects of the latent independent variables on the latent dependent variables. All the direct effects of the latent independent variables on the latent dependent variables were given in Table 4.43.

Table 4.43 Direct Effects of Latent Independent Variables on Latent Dependent Variables for Mathematical Literacy Model for Norway

	ATTREAD	RELATION	CLIMATE	COM	USAGE
ATTMATH	-	-	-	-	-
READLIT	0.33	0.14	-0.01	0.12	-0.06
MATHLIT	-0.13	-	0.01	-	0.02

LISREL output of the model also presented the indirect effects and the total effects of latent independent variables on latent dependent variables. The values of the indirect effects and total effects of latent independent variables on latent dependent variables were displayed in Table 4.44 and Table 4.45.

Table 4.44 Indirect Effects of Latent Independent Variables on Latent Dependent Variables of Mathematical Literacy Model for Norway

	ATTREAD	RELATION	CLIMATE	COM	USAGE
ATTMATH	0.06	0.04	0.00	0.04	-0.01
READLIT	-	-	-	-	-
MATHLIT	0.28	0.12	-0.01	0.11	-0.05

Table 4.45 Total Effects of Latent Independent Variables on Latent Dependent Variables of Mathematical Literacy Model for Norway

	ATTREAD	RELATION	CLIMATE	COM	USAGE
ATTMATH	0.06	0.04	0.00	0.04	-0.01
READLIT	0.33	0.14	-0.01	0.12	-0.06
MATHLIT	0.15	0.12	0.00	0.11	-0.02

The results displayed in Figure 4.5 further show that ATTREAD had a positive direct effect on READLIT ($\Gamma = 0.33$, $p < 0.05$). RELATION had a positive direct effect on READLIT ($\Gamma = 0.14$, $p < 0.05$). CLIMATE had a non-significant and negative direct effect on READLIT ($\Gamma = -0.01$, $p > 0.05$). COM had a positive direct effect on READLIT ($\Gamma = 0.12$, $p < 0.05$). USAGE had a non-significant and negative direct effect on READLIT ($\Gamma = -0.06$, $p > 0.05$).

Since the latent independent variables did not have any direct effect on ATTMATH, the indirect effects of latent independent variables on ATTMATH would be investigated. ATTREAD and RELATION had significant and positive indirect effects of 0.06 and 0.04, respectively, on ATTMATH. CLIMATE had a significant indirect effect of 0.00 on ATTMATH. COM had a positive and significant indirect effect of 0.04 on ATTMATH. USAGE had a negative and significant indirect effect of -0.01 on ATTMATH.

ATTREAD had a negative direct effect on MATHLIT ($\Gamma = -0.13$, $p < 0.05$). The latent independent variable CLIMATE had a significant and positive direct effect on MATHLIT ($\Gamma = 0.04$, $p < 0.05$). And USAGE had a positive and significant direct effect on MATHLIT ($\Gamma = 0.11$, $p < 0.05$). The latent independent variables also had indirect effects on MATHLIT. The latent independent variable ATTREAD had a positive and significant indirect effect of 0.28 on MATHLIT. RELATION had a positive and significant indirect effect of 0.12 on MATHLIT. CLIMATE had a significant and negative indirect effect of -0.01 on MATHLIT. COM had a positive and significant indirect effect of 0.11 on MATHLIT. USAGE had a significant and negative indirect effect of -0.05 on MATHLIT.

According to the Table 4.45, the total effect of ATTREAD on READLIT was 0.33 indicating a significant and positive effect ($\Gamma = 0.33$, $p < 0.05$). The total effect of RELATION on READLIT was 0.14 indicating a significant and positive effect ($\Gamma = 0.14$, $p < 0.05$). The total effect of CLIMATE on READLIT was -0.01 indicating a non-significant and negative effect ($\Gamma = 0.14$, $p > 0.05$). The total effect of COM on READLIT was 0.12 indicating a significant and positive effect ($\Gamma = 0.12$, $p < 0.05$). The total effect of USAGE on READLIT was -0.06 indicating a non-significant and negative effect ($\Gamma = -0.06$, $p > 0.05$).

The total effect of ATTREAD on ATTMATH was 0.06 indicating a significant effect. The total effect of RELATION on ATTMATH was 0.04 indicating a significant effect. The total effect of CLIMATE on ATTMATH was 0.00 indicating a significant effect. The total effect of COM on ATTMATH was 0.04 indicating a significant effect. The total effect of USAGE on ATTMATH was -0.01 indicating a significant and negative effect.

The total effect of ATTREAD on MATHLIT was 0.15 indicating a significant and positive effect. The total effect of RELATION on MATHLIT was 0.12 indicating a significant and positive effect. The total effect of CLIMATE on MATHLIT was 0.00 indicating a significant effect. The total effect of COM on MATHLIT was 0.11 indicating a significant and positive effect. The total effect of USAGE on MATHLIT was -0.02 indicating a significant effect.

Finally, among the latent independent variables, ATTREAD had the greatest total effect of 0.33 which was significant, positive effect on READLIT ($\Gamma = 0.25$, $p < 0.05$). One of the latent independent variables, ATTREAD had greatest total effect of 0.06 indicating a significant, positive effect on ATTMATH. Among the latent independent variables, ATTREAD had the greatest total effect of 0.15 which is significant, positive effect on MATHLIT.

The results displayed in Figure 4.5 further showed the direct effects of the latent dependent variables on the latent dependent variables. All the direct effects between the latent dependent variables were given in Table 4.46.

Table 4.46 Direct Effects between Latent Dependent Variables of Mathematical Literacy Model for Norway

	ATTMATH	READLIT	MATHLIT
ATTMATH	-	-	0.36
READLIT	-	-	-
MATHLIT	0.17	0.83	-

LISREL output of the model also presented the indirect effects and the total effects of latent dependent variables on latent dependent variables. The values of the indirect effects and total effects between the latent dependent variables were displayed in Table 4.47 and Table 4.48.

Table 4.47 Indirect Effects between Latent Dependent Variables of Mathematical Literacy Model for Norway

	ATTMATH	READLIT	MATHLIT
ATTMATH	0.07	0.32	0.02
READLIT	-	-	-
MATHLIT	0.01	0.05	0.07

Table 4.48 Total Effects between Latent Independent Variables of Mathematical Literacy Model for Norway

	ATTMATH	READLIT	MATHLIT
ATTMATH	0.07	0.32	0.38
READLIT	-	-	-
MATHLIT	0.18	0.88	0.07

The latent dependent variables did not have any effects on the latent dependent variable READLIT. The latent dependent variables had direct and indirect effects on ATTMATH. The latent dependent variable READLIT had a positive and significant indirect effect of 0.32 on ATTMATH. The latent dependent variable MATHLIT had also a positive and significant direct effect of 0.36 on ATTMATH ($\beta = 0.36$, $p < 0.05$) and a significant indirect effect of 0.02 on ATTMATH. Moreover, ATTMATH had a significant indirect effect of 0.07 to itself.

Furthermore, the latent dependent variables had direct and indirect effects on MATHLIT. The latent dependent variable ATTMATH had a positive and significant direct effect of 0.17 on MATHLIT ($\beta = 0.17$, $p < 0.05$) and also a significant indirect effect of 0.01 on MATHLIT. READLIT had a positive and significant direct effect of 0.83 on MATHLIT ($\beta = 0.83$, $p < 0.05$). READLIT also had a significant indirect effect of 0.05 on MATHLIT. Lastly, MATHLIT had a significant indirect effect of 0.07 to itself.

The total effect of latent dependent variable READLIT on ATTMATH was 0.32 indicating a significant and positive effect. The total effect of ATTMATH on itself was 0.07 which was significant and positive. Finally, the total effect of MATHLIT on ATTMATH was 0.38 indicating a positive and significant effect.

The total effect of latent dependent variable READLIT on MATHLIT was 0.88 indicating a significant and positive effect. The total effect of ATTMATH on MATHLIT was 0.18 indicating a positive and significant effect. And lastly, the total effect of MATHLIT on itself was 0.07 which was significant and positive.

The latent dependent variable, MATHLIT had the greatest total effect of 0.38 which was significant, positive effect on ATTMATH. Among the latent dependent variables, READLIT had a significant, positive and direct effect of 0.88 on MATHLIT. As predicted, reciprocal relationship between ATTMATH and MATHLIT is found. The parameter estimates in Figure 4.5 showed that ATTMATH positively effect MATHLIT ($\beta= 0.17$, $p < 0.05$) and at the same time, MATHLIT had a positive effect on ATTMATH ($\beta= 0.36$, $p < 0.05$). Reciprocal effects that ATTMATH and MATHLIT have between each other were different in magnitude. A conclusion about the reciprocal effects of ATTMATH and MATHLIT could be made as MATHLIT had a stronger effect on ATTMATH in the mathematical literacy model for Norway.

CHAPTER 5

DISCUSSION, CONCLUSION AND IMPLICATIONS

The purpose of the study is to model the factors affecting the mathematical literacy of 15-year-old students in Brazil, Japan and Norway. This chapter includes the discussion and the conclusion of the results and the interpretation of the findings presented in the present study.

5.1 Discussion of the Results

No models, related with the included factors in this study, were present in the literature. However, some modeling studies could be found in the literature including some of the factors contained in this study.

This study explored how mathematical literacy is stimulated by predictors related to the students, the family and the school. The included factors were selected in accordance with the property of changeable. That is, the effects of these factors in this study can be changed by the help of the families and the schools. For instance, the negative attitudes of the students towards a particular subject can be overcome by the efforts of the families and the teachers. In contrast, the variables such as gender and socioeconomic status cannot be changed over time. Thus, the included factors affecting mathematical literacy are the attitudes towards reading, student-teacher relations, climate, communication with parents, usage of technology and facilities, attitudes towards mathematics and reading literacy. The data from Brazil, Japan and Norway was used in the analyses as representatives of three groups of countries.

Japan was selected as the high performing country, Norway as the average performing country and Brazil as the low performing country in PISA project.

The results of this study support the findings in the previous research in the literature with respect to the relationship of the reading and mathematical literacy. According to Briggs, Kolstad and Whalen (1996), mathematics became a less of a pure number exercise and more of a speaking, reading enterprise, which basically is the way practical mathematics is presented in everyday life. The mathematics curriculum includes the development of language and symbolism to communicate mathematical ideas and relationships (Grossman, Smith & Miller, 1993). Capps and Pickreign (1993) suggested that students must learn to communicate mathematically, in writing and through oral language. Therefore, a high correlation exists between the verbal achievement and the mathematics achievement indicators (Marsh, 1996). The findings of this study support the results of the previous studies. According to the models of three countries, reading literacy significantly and positively loaded on mathematical literacy in Brazil, Japan and Norway ($\beta = 0.83$, $\beta = 0.89$, $\beta = 0.88$, $p < 0.05$). Consequently, reading literacy has a very high and positive influence on mathematical literacy. The highest influence of reading literacy on mathematical literacy is found in Japan. One possible explanation of this result is the complexity and formality of Japanese language in both written and spoken forms. According to Deasy (1986), talking to a friend is different from talking to a teacher in Japan. The speaking adjusts the language to the person being spoken to, not just through the addition of polite expressions, but by complete shifts in vocabulary and grammatical form. Thus, Japanese are said to spend their lives learning to read and write their own language.

A reciprocal relationship between the attitudes towards mathematics and mathematical literacy is presented in the models of Brazil and Norway. This reciprocal relationship cannot be presented in the model of Japan, because of the lack of the data of the attitudes towards mathematics. Since the cross-curricular competencies questionnaire was not administered in Japan, the Japanese students did not report their attitudes towards mathematics. Ma (1997) studied on the reciprocal relationship between the attitudes towards mathematics and achievement in mathematics by using structural equation modeling. In the study, Ma (1997) found that the reciprocal relationship exists between these variables. That is, attitudes affect achievement and achievement inturn affects attitudes. Results of this study are consistent with the Ma's (1997) study. In the present study, the attitudes towards mathematics affect mathematical literacy and mathematical literacy inturn affects the attitudes towards mathematics. In the model of Brazil, the effect of attitudes towards mathematics on mathematical literacy is greater than the effect of mathematical literacy on attitudes towards mathematics ($\beta = 0.09$, $\beta = 0.07$, $p < 0.05$). Therefore, the attitudes towards mathematics influence mathematical literacy more than the mathematical literacy influences the attitudes towards mathematics. On the other hand, in the model of Norway, the effect of mathematical literacy on attitudes towards mathematics is greater than the effect of attitudes towards mathematics on mathematical literacy ($\beta = 0.38$, $\beta = 0.18$, $p < 0.05$). Therefore, the influence of mathematical literacy on attitudes towards mathematics is higher than the influence of attitudes towards mathematics on mathematical literacy. As a result, the students in Brazil having positive attitudes towards mathematics tend to perform better on mathematical literacy. In contrast, the students in Norway performing better on mathematical literacy tend to have more positive attitudes towards mathematics. This finding is consistent with the findings of the studies of Marsh (1986), Eccles, Meece and Wigfield (1990), Tocci and Engelhard (1991), Reynolds and Walberg (1992), Abu-Hilal (2000) and Schreiber (2002) that is there is a reciprocal relationship between the attitudes towards mathematics and mathematical literacy.

The results of this study support the hypothesis that attitudes towards reading influence the reading literacy. Attitudes towards reading positively and significantly loaded on reading literacy in Brazil, Japan and Norway ($\Gamma= 0.08$, $\Gamma= 0.21$, $\Gamma= 0.33$, $p < 0.05$). This finding concurs with the previous studies in which the relationship between the attitudes towards reading and achievement in reading is significant and often positive (Greenberg, Gerver, Chall & Davidson, 1965; Askov & Fishbach, 1973; Rowell, 1972-1973; Nielson, 1978, Roettger, Szymezuk & Millard, 1979; Tocci & Engelhard, 1991). Thus, students having positive attitudes towards reading tend to perform better in reading literacy. This result of this study also coincides with the findings of the studies which suggested that students having positive attitudes contribute meaningfully to higher achievement in reading (Schofield, 1980; Quinn & Jadav, 1987; Papanastasiou, 2002). According to the models of three countries, the attitudes towards reading have the strongest influence on reading literacy in Norway.

One possible explanation of this result is that the main principle in Norwegian basic school which every pupil should have education in accordance with his capability and qualification. As Holm (2002) indicated, the fundamental of all basic teaching stated in the Act of the Basic School, is that every pupil, whatever his capabilities or need, shall be given education accordingly.

When looked at the relationship between the attitudes towards reading and mathematical literacy, a direct and negative relation is found. That is, attitudes towards reading significantly and negatively loaded on mathematical literacy in Brazil, Japan and Norway ($\Gamma = -0.09$, $\Gamma = -0.14$, $\Gamma = -0.13$, $p < 0.05$). According to Marsh (1986), the relationship between the mathematics achievement and the verbal self-concept is significantly negative. Thus, the result of this study coincides with the findings in the previous studies. Generally, the students being interested in reading and having qualitative intelligence are less interested in the quantitative subjects such as mathematics. Accordingly, these students with positive attitudes towards reading cannot have high performance in mathematical literacy. As predicted, the attitudes towards reading have a negative direct influence on mathematical literacy. Based on the models of the three models of the countries, the strongest negative effect of attitudes towards reading on mathematical literacy is found in Japan. Therefore, the Japanese students having negative attitudes towards reading tend to perform better on mathematical literacy. Because of the complexity and formality of the Japanese language, the students can have negative attitudes towards reading. As in the result, these students perform better on mathematical literacy in accordance with the negative attitudes towards reading. The Japanese students do well on international mathematics tests as Deasy (1986) stated. In addition, Cave (2001) suggested that Japanese children have performed well in the international mathematics and science tests organized by the IEA, most recently the Third International Mathematics and Science Study (TIMSS) carried out in 1994-1995 and the TIMSS Repeat Survey carried out in 1999.

The attitudes towards reading have also indirect effect on mathematical literacy over reading literacy. This indirect effect is significant and positive. That is, attitudes towards reading indirectly and positively influence the mathematical literacy, with an effect of 0.07, 0.19 and 0.28 in Brazil, Japan and Norway, respectively. Since the attitudes towards reading positively affect the reading literacy and reading literacy has a positive and large effect on mathematical literacy, then the attitudes towards reading is positively related to mathematical literacy. As can be seen, the strongest indirect influence of attitudes towards reading on mathematical literacy is found in Norway. This result is logical and related to the previous studies. Because attitudes towards reading have the strongest influence on reading literacy in Norway.

Attitudes towards reading have also significant and positive influence on the attitudes towards mathematics in Brazil and Norway, with the effects of 0.00 and 0.06, respectively. Since attitudes towards reading influence reading literacy, reading literacy is highly related with mathematical literacy and mathematical literacy has an effect on attitudes towards mathematics, then attitudes towards reading indirectly influence attitudes towards mathematics.

According to the studies in the literature, the relationship between the student-teacher relations and the achievement is generally positive, indicating that the interactions of the students with the teachers affect the student performance (Hill & Rowe, 1996; Rowe, 1997a; Hill & Rowe, 1998). The results of the models of Japan and Norway, student-teacher relations have significant and positive influences both in reading and mathematical literacy. Student-teacher relations positively loaded on reading literacy with the effects of 0.07 and 0.14 in Japan and Norway, respectively. Moreover, the student-teacher relations also positively loaded on mathematical literacy with the effects of 0.06 and 0.12 in Japan and Norway, respectively. Student-teacher relations have the strongest influence on both reading and mathematical literacy in Norway. One possible explanation is that the interaction between teachers and pupils is the fundamental importance in Norway in providing a feeling of wellbeing in the learning environment and for determining how much pupils benefit from the teaching. According to Hansen and Simonsen (2001), the teachers in Norway are mentors, masters and mothers since the mandate and the subject content require a master; understanding the pupils and creating a good environment require both a master and a mother; and coping with more free organized learning activities requires both a mentor and a mother. Thus, when there is a good interaction between the student and teacher, the student tends to perform better in reading and mathematical literacy. In contrast, the student-teacher relations negatively influence the reading and mathematical literacy in Brazil. The effects of student-teacher relations on reading and mathematical literacy are -0.09 and -0.07, respectively. A possible explanation for the result in Brazil is that the teachers typically use more supportive practices in the classes attended by a majority of less able students. Since the teachers mostly communicate and pay attention to the less able students, the correlation between the student-teacher relations and the performance of the students would be expected to be negative.

Student-teacher relations also significantly and positively influence the attitudes towards mathematics in Brazil and Norway. The effects of the relations of teacher with the students on attitudes towards mathematics are 0.00 for Brazil and 0.04 for Norway. Because student-teacher relations have an effect on reading literacy, reading literacy highly influences mathematical literacy and mathematical literacy is related to attitudes towards mathematics, then student-teacher relations have an effect on attitudes towards mathematics.

The student-related factors affecting school climate are significantly and positively loaded on reading and mathematical literacy in Brazil, with the effects of 0.09 and 0.12, respectively. Thus, the school climate has a positive influence on both reading and mathematical literacy. This result supports the findings of the previous studies of Brookover, Beady, Flood, Schweitzer and Wisenbaker (1979), Willms (1992), Scheerens and Bosker (1997) and Bos and Kuiper (1999). These studies indicated that the school climate variables have a direct influence on the student achievement. The school climate is significantly but negatively loaded on reading and mathematical literacy in Japan, with the effects of -0.19 and -0.15, respectively. That is, school climate negatively influences the reading and mathematical literacy. One possible explanation is that discipline and order in schools are very essential elements in Japan. According to Deasy (1986), the harmony and order are thought as not simply the rules of the school, but also social assumptions. Perhaps, this strict harmony and order play a negative role in the motivation of the students. According to the model of Norway, the school climate is not significantly loaded on reading and mathematical literacy, with the effects of -0.06 and -0.02, respectively. Therefore, the school climate is not related to both reading and mathematical literacy in Norway. One possible explanation is that the teachers try to create a good learning environment through a variety of methods and means of expression. According to Hansen and Simonsen (2001), the teachers try to shape a good learning environment by creating good social interaction and grouping of pupils and by the appropriate organization of every pupil’s work.

School climate has also significant and positive indirect influence on the attitudes towards mathematics in Brazil, with an effect of 0.01 and in Norway, with an effect of 0.00. Since these indirect effects caused by the direct effects, these results are logical. This indirect effect on attitudes towards mathematics is over reading and mathematical literacy and in addition over mathematical literacy.

Communication with parents is positively and significantly loaded on reading literacy in Brazil, Japan and Norway ($\Gamma = 0.22$, $\Gamma = 0.23$, $\Gamma = 0.12$, $p < 0.05$). In addition, communication with parents is also positively and significantly loaded on mathematical literacy in Brazil, Japan and Norway ($\Gamma = 0.18$, $\Gamma = 0.21$, $\Gamma = 0.11$, $p < 0.05$). That is, communication with parents contributes high performance in both reading and mathematical literacy. This finding supports the findings of the previous studies of Sewell and Hauser (1980), Nelson (1984), Tocci and Engelhard (1991), Reynolds and Walberg (1992), Entwisle and Alexander (1996), Ferry, Fouad and Smith (2000) that is communication with parents is highly related with the performance of the students. According to the models of three countries, the communication between the parents and their children has the strongest effect on both reading and mathematical literacy in Japan. One possible explanation is that the family is still stable and deep core of the Japanese society. According to Deasy (1986), generally it is the mother who watches over nightly homework; researches the public and private schools to decide which will best prepare her children for the university and college examinations; arranges their enrollment in juko, the supplementary private schools widely used to give added instruction in everything from dance to mathematics; and serves as a constant reminder of the children’s expected performance level. Consequently, women in Japan are expected to attend to the inner world of the family in which the education of children is a central concern.

Communication with parents has also significantly and positively influences the attitudes towards mathematics in Brazil and Norway, with the effects of 0.01 and 0.04, respectively. Since communication with parents has an effect on reading literacy, reading literacy is related to mathematical literacy and mathematical literacy affects the attitudes towards mathematics, then communication with parents influences the attitudes towards mathematics.

The results of this study support the hypothesis that the usage of technology and facilities influences the reading and mathematical literacy. The usage of the school resources such as computers, calculators and library has significant and positive effects of 0.25 and 0.32 on reading and mathematical literacy, respectively in Brazil. That is, the usage of school resources has a positive influence on reading and mathematical literacy in Brazil. This result supports the findings of previous studies in the literature that educational resources are closely related to performance and have an influence on student achievement (Oaker, 1989; Greenwald, Hedges & Laine, 1996; D'Agostino, 2000; Schreiber, 2002). When looked at the results of the model of Japan, the usage of school resources are significantly and negatively loaded on reading and mathematical literacy, with the effects of -0.07 and -0.09, respectively. That is, the usage of technology and facilities negatively influences the reading and mathematical literacy. This interesting result was found in the study of Papanastasiou (2002) about TIMSS, that the less the students use computers in their classrooms, the higher their mathematics scores are. In the study, the highest means are found to belong generally to students who never used computers. Lastly, according to the model of Norway, the usage of school resources is found to be non-significantly loaded on reading and significantly loaded on mathematical literacy, with the effects of -0.06 and -0.02, respectively. Thus, the usage of technology and facilities is not related with reading and negatively related with mathematical literacy in Norway. One possible explanation for this interesting result is that the usage of school resources such as computers and calculators lead to a disadvantage for the students. Students cannot do the basic operations by themselves because of the adaptation to the computers and calculators.

The usage of technology and facilities has also significant and positive effect of 0.02 on attitudes toward mathematics in Brazil. In contrast, the usage of school resources significantly but negatively affects attitudes towards mathematics in Norway, with an effect of -0.01. Since these indirect effects caused by the direct effects, these results are logical. This indirect effect on attitudes towards mathematics is over reading and mathematical literacy and in addition over mathematical literacy.

The latent independent variables such as attitudes towards reading, student-teacher relations, climate, communication with parents and usage of technology and facilities are included in the present study. In Brazil, the latent independent variable having the strongest effect on both reading and mathematical literacy is the usage of technology and facilities. This result is logical according to the findings of other studies. Marcondes (1999) suggested that explanations for school failure and grade repetition in Brazil can generally be related to the low quality of some schools. There are unprepared teachers with low levels of education, low salaries and few material resources such as textbooks and audio-visual equipment. The working conditions in classroom are also poor. Altogether, these factors contribute strongly to the teachers' and students' lack of motivation. As Marcondes (1999) indicated, the usage of technology and facilities can contribute the low performance of the students in the PISA project.

In Japan, the latent independent variable strongly affecting both reading and mathematical literacy is the communication with parents. This result is consistent with the findings of Deasy (1986), that the family is still stable and deep core of the Japanese society. The women are expected to attend in the inner world of the family in which the education of children is a central concern. Since the families communicate with their children, this causes the high performance of the students in the PISA project.

In Norway, the latent independent variable having the strongest influence on both reading and mathematical literacy is the attitudes towards reading. This result coincides with the findings of Hansen and Simonsen (2001) that every pupil have education in accordance with his capability and qualification. The fundamental of all basic teaching is that every pupil, whatever his capabilities and need, shall be given education accordingly. Moreover, the conditions under which the pupils learn are also determined by how pupils are grouped and the arrangements made to provide opportunities for social contact and joint activities. It is an environment that stimulates learning and personal development. As Hansen and Simonsen (2001) indicated, all these contribute to positive attitudes towards learning. Therefore, the attitudes of the students are the strongest factor in their performance in reading and mathematical literacy.

5.2 Conclusion

The factors affecting the mathematical literacy in PISA project are investigated through Brazil, Japan and Norway by using structural equation modeling. The three countries were selected in accordance with their level of performance. Japan represented a high performing country, Norway represented an average performing country and Brazil represented a low performing country. The factors affecting mathematical literacy are determined in accordance with their possibility to be changed in education systems. The factors included in the study are attitudes towards reading, student-teacher relations, climate, communication with parents, usage of technology and facilities, attitudes towards mathematics and reading literacy. Since Turkey did not participate in PISA 2000 project, this study could not contain Turkey. However, PISA project is repeated in 2003 with an emphasis given to the mathematical literacy and Turkey is one of the participating countries in the repeated PISA project. Therefore, more studies will be conducted for Turkey as soon as the data of Turkey is obtained.

The results of this study are generally consistent with the findings of the previous research in the literature. The results of the present study are summarized below:

1. The attitudes towards reading significantly and positively influence reading literacy in all three countries. This means that the students having positive attitudes towards reading tend to perform better on reading literacy.

2. There is a direct effect of attitudes towards reading on mathematical literacy. This direct effect is significant and negative in all three countries. Thus, the students being interested in qualitative subjects, like reading are less interested in the quantitative subjects such as mathematics.

3. An indirect effect of attitudes towards reading on mathematical literacy exists over reading literacy. This indirect effect is significant and positive in all three countries indicating that students having positive attitudes towards reading tend to perform better on reading literacy and correspondingly on mathematical literacy.

4. The attitudes towards reading also significantly and positively influence the attitudes towards mathematics in Brazil and Norway. This influence is obtained by the indirect effect of attitudes towards reading on attitudes towards mathematics over both reading literacy and mathematical literacy.

5. The relationship between the teacher and the student significantly and positively affects both the reading and mathematical literacy in Japan and Norway. Thus, the interactions between the teacher and the student are closely related to reading and mathematical literacy in Japan and Norway.

6. The student-teacher relations significantly but negatively influence both reading and mathematical literacy in Brazil. The teacher may mostly communicate and pay attention to the less able students and correspondingly the correlation between the student-teacher relations and the performance of the students would be expected to be negative.

7. There is an indirect effect of student-teacher relations on the attitudes towards mathematics. This indirect influence is significant and positive in Brazil and Norway. Since the indirect effect of student-teacher relations and attitudes towards mathematics is over both reading and mathematical literacy, these results are correspondingly logical.

8. The student-related factors affecting school climate are significantly and positively related with reading and mathematical literacy in Brazil. Thus, the school climate has a direct influence on student performance in reading and mathematical literacy.

9. There is a significant but negative influence of school climate on reading and mathematical literacy in Japan. Perhaps, the strict harmony and order play a negative role in the motivation of the students and correspondingly result low performance of the students.

10. The school climate does not have a significant effect on reading and mathematical literacy in Norway. This means that the school climate does not have any influence on reading and mathematical literacy.

11. School climate has a significant and positive indirect influence on the attitudes towards mathematics in Brazil and Norway. Because the indirect influence of school climate on attitudes towards mathematics exists over both reading and mathematical literacy, these results are correspondingly logical.

12. Communication with parents significantly and positively affects both reading and mathematical literacy in all three countries. Thus, communication with parents contributes high performance in both reading and mathematical literacy.

13. There is a significant and positive indirect effect of the communication with parents on attitudes towards mathematics in both Brazil and Norway. That is, the students communicating well with their parents tend to have positive attitudes towards mathematics.

14. The usage of technology and facilities such as computers, calculators and library significantly and positively influences both reading and mathematical literacy in Brazil. Therefore, the more the students in Brazil use school resources, the better they perform on reading and mathematical literacy.

15. The usage of technology and facilities significantly and negatively affects both reading and mathematical literacy in Japan. Thus, the higher performance on reading and mathematical literacy is found to belong generally to students not using school resources.

16. The effect of the usage of school resources is non-significant on reading and significant in mathematical literacy in Norway. That is, the usage of technology and facilities are not related with reading and negatively related with mathematical literacy.

17. There is a significant and positive indirect effect of the usage of school resources on attitudes towards mathematics in Brazil. However, the effect of the usage of school resources on attitudes towards mathematics is significant and negative in Norway. Since the indirect effect of the usage of school resources on attitudes towards mathematics is over both reading and mathematical literacy, these results are correspondingly logical.

18. In Brazil, the latent independent variable having the strongest effect on both reading and mathematical literacy is the usage of technology and facilities. On the other hand, the latent independent variables having the strongest effects on both reading and mathematical literacy are communication with parents in Japan and the attitudes towards reading in Norway.

19. Reading literacy significantly and positively influences the mathematical literacy in all three countries. The effect of reading literacy on mathematical literacy is very high. Thus, the students performing high on reading literacy tend to perform high on mathematical literacy.

20. There is a reciprocal relationship between the attitudes towards mathematics and the mathematical literacy. In Brazil, the influence of attitudes towards mathematics on mathematical literacy is higher. However, in Norway, the influence of mathematical literacy on the attitudes towards mathematics is higher. Therefore, the students in Brazil having positive attitudes towards mathematics tend to perform high on mathematical literacy. On the other hand, the students in Norway performing high on mathematical literacy tend to have more positive attitudes towards mathematics.

5.3 Implications

The implications of the present research in accordance with the conclusions can be stated as the followings:

- The teachers should recognize and try to overcome the problem of the negative attitudes of the students towards reading and instructional consequences of these attitudes.
- The teachers should try to communicate and pay attention to the students in order to have good relationships with the students.
- The teachers should create such a classroom climate that a good learning environment is shaped.
- The families should be aware of their importance in the performance of their children and pay attention to create a good communication with their children. In addition, more parental involvement should be encouraged.
- The teachers and the families should make the children to use library in order to teach them searching.
- The necessary steps should be acquired in order to include language in mathematics. Therefore, the students will not think about mathematics as cold and threatening. In addition, mathematics will become more of a speaking and reading enterprise which basically the way practical mathematics is presented in everyday life. The benefits of incorporating reading, writing and oral language into mathematics instruction are to help students convey mathematical information in familiar words and assist them with their thinking processes, as they work through math calculations and problem solving situations. In addition, the students' abilities to communicate mathematically will improve by including oral language activities in mathematics lessons.
- The teachers should be careful about the attitudes of the students towards mathematics and their performance in mathematics since there is a reciprocal relationship between the attitudes towards mathematics and mathematical literacy. The teachers should provide conditions such that the students will see mathematics from a different perspective.

5.4 Recommendations for Further Researchers

The following are the recommendations for further researchers on the modeling of the factors affecting mathematical literacy.

- The researcher can carry out research on modeling the factors investigated in mathematics education by using structural equation modeling since not many studies are conducted on modeling in Turkey.
- The researcher can carry out further research to investigate the effects of the factors included in this study in detail.
- The researcher can carry out further research on modeling the factors affecting mathematical literacy in PISA project including the other factors in the student questionnaire that are not contained in the present study.
- The researcher can carry out further research on modeling the factors affecting mathematical literacy in PISA project including the other factors in the cross-curricular competencies questionnaire that are not contained in the present study.
- The researcher can carry out further research on modeling the factors affecting mathematical literacy in PISA project including the factors in the computer familiarity questionnaire.
- The researcher can carry out further research on modeling the factors affecting mathematical literacy in PISA project including the factors in the school questionnaire.
- The researcher can carry out further research on modeling the factors affecting mathematical literacy in PISA project for Turkey after the data of Turkey is obtained.

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APPENDIX A

THE FREQUENCY DISTRIBUTIONS OF THE OBSERVED VARIABLES

A.1 The Frequency of "Favourite Hobby" with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Strongly Disagree	321	11.8
	Disagree	981	36.1
	Agree	947	34.9
	Strongly Agree	341	12.6
	Total	2 590	95.3
	Missing	127	4.7
	Total	2 717	100.0
JAPAN	Strongly Disagree	1 003	34.3
	Disagree	809	27.7
	Agree	593	20.3
	Strongly Agree	433	14.8
	Total	2 838	97.1
	Missing	86	2.9
	Total	2 924	100.0
NORWAY	Strongly Disagree	929	40.3
	Disagree	792	34.3
	Agree	380	16.5
	Strongly Agree	145	6.3
	Total	2 246	97.4
	Missing	61	2.6
	Total	2 307	100.0

A.2 The Frequency of "Feel Happy" with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Strongly Disagree	325	12.0
	Disagree	567	20.9
	Agree	1 278	47.0
	Strongly Agree	399	14.7
	Total	2 569	94.6
	Missing	148	5.4
	Total	2 717	100.0
JAPAN	Strongly Disagree	752	25.7
	Disagree	913	31.2
	Agree	787	26.9
	Strongly Agree	381	13.0
	Total	2 833	96.9
	Missing	91	3.1
	Total	2 924	100.0
NORWAY	Strongly Disagree	751	32.6
	Disagree	636	27.6
	Agree	699	30.3
	Strongly Agree	147	6.4
	Total	2 233	96.8
	Missing	74	3.2
	Total	2 307	100.0

A.3 The Frequency of "Enjoy Library" with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Strongly Disagree	260	9.6
	Disagree	700	25.8
	Agree	1 278	47.0
	Strongly Agree	326	12.0
	Total	2 564	94.4
	Missing	153	5.6
	Total	2 717	100.0
JAPAN	Strongly Disagree	378	12.9
	Disagree	568	19.4
	Agree	1 021	34.9
	Strongly Agree	862	29.5
	Total	2 829	96.8
	Missing	95	3.2
	Total	2 924	100.0
NORWAY	Strongly Disagree	713	30.9
	Disagree	650	28.2
	Agree	685	29.7
	Strongly Agree	173	7.5
	Total	2 221	96.3
	Missing	86	3.7
	Total	2 307	100.0

A.4 The Frequency of “Talking About Books” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Strongly Disagree	346	12.7
	Disagree	856	31.5
	Agree	1 085	39.9
	Strongly Agree	282	10.4
	Total	2 569	94.6
	Missing	148	5.4
	Total	2 717	100.0
JAPAN	Strongly Disagree	932	31.9
	Disagree	867	29.7
	Agree	720	24.6
	Strongly Agree	313	10.7
	Total	2 832	96.9
	Missing	92	3.1
	Total	2 924	100.0
NORWAY	Strongly Disagree	986	42.7
	Disagree	781	33.9
	Agree	391	16.9
	Strongly Agree	80	3.5
	Total	2 238	97.0
	Missing	69	3.0
	Total	2 307	100.0

A.5 The Frequency of “Only If I Have To” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Strongly Disagree	509	18.7
	Disagree	937	64.5
	Agree	906	33.3
	Strongly Agree	248	9.1
	Total	2 600	95.7
	Missing	117	4.3
	Total	2 717	100.0
JAPAN	Strongly Disagree	804	27.5
	Disagree	678	23.2
	Agree	732	25.0
	Strongly Agree	620	21.2
	Total	2 834	96.9
	Missing	90	3.1
	Total	2 924	100.0
NORWAY	Strongly Disagree	507	22.0
	Disagree	775	33.6
	Agree	553	24.0
	Strongly Agree	410	17.8
	Total	2 245	97.3
	Missing	62	2.7
	Total	2 307	100.0

A.6 The Frequency of "Few Minutes Only" with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Strongly Disagree	732	26.9
	Disagree	1 152	42.4
	Agree	542	19.9
	Strongly Agree	163	6.0
	Total	2 589	95.3
	Missing	128	4.7
	Total	2717	100.0
JAPAN	Strongly Disagree	1 200	41.0
	Disagree	883	30.2
	Agree	436	14.9
	Strongly Agree	323	11.0
	Total	2 842	97.2
	Missing	82	2.8
	Total	2 924	100.0
NORWAY	Strongly Disagree	894	38.8
	Disagree	784	34.0
	Agree	299	13.0
	Strongly Agree	252	10.9
	Total	2 229	96.6
	Missing	78	3.4
	Total	2 307	100.0

A.7 The Frequency of "Waste Of Time" with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Strongly Disagree	1 016	37.4
	Disagree	1 261	46.4
	Agree	211	7.8
	Strongly Agree	70	2.6
	Total	2 558	94.1
	Missing	159	5.9
	Total	2 717	100.0
JAPAN	Strongly Disagree	1 250	42.7
	Disagree	1 039	35.5
	Agree	357	12.2
	Strongly Agree	185	6.3
	Total	2 831	96.8
	Missing	93	3.2
	Total	2 924	100.0
NORWAY	Strongly Disagree	695	30.1
	Disagree	842	36.5
	Agree	373	16.2
	Strongly Agree	315	13.7
	Total	2 225	96.4
	Missing	82	3.6
	Total	2 307	100.0

A.8 The Frequency of “Listen To Me” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Strongly Disagree	127	4.7
	Disagree	499	18.4
	Agree	1 343	49.4
	Strongly Agree	641	23.6
	Total	2 610	96.1
	Missing	107	3.9
	Total	2 717	100.0
JAPAN	Strongly Disagree	320	10.9
	Disagree	1 070	36.6
	Agree	1 268	43.4
	Strongly Agree	146	5.0
	Total	2 804	95.9
	Missing	120	4.1
	Total	2 924	100.0
NORWAY	Strongly Disagree	246	10.7
	Disagree	755	32.7
	Agree	1 063	46.1
	Strongly Agree	182	7.9
	Total	2 246	97.4
	Missing	61	2.6
	Total	2 307	100.0

A.9 The Frequency of “Interested In Students” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Strongly Disagree	95	3.3
	Disagree	411	15.1
	Agree	1 454	53.5
	Strongly Agree	657	24.2
	Total	2 617	96.3
	Missing	100	3.7
	Total	2 717	100.0
JAPAN	Strongly Disagree	352	12.0
	Disagree	925	31.6
	Agree	1 371	46.9
	Strongly Agree	166	5.7
	Total	2 814	96.2
	Missing	110	3.8
	Total	2 924	100.0
NORWAY	Strongly Disagree	200	8.7
	Disagree	638	27.7
	Agree	1 247	54.1
	Strongly Agree	170	7.4
	Total	2 255	97.7
	Missing	52	2.3
	Total	2 307	100.0

A.10 The Frequency of “Give Extra Help” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Strongly Disagree	53	2.0
	Disagree	228	8.4
	Agree	1 547	56.9
	Strongly Agree	786	28.9
	Total	2 614	96.2
	Missing	103	3.8
	Total	2 717	100.0
JAPAN	Strongly Disagree	244	8.3
	Disagree	723	24.7
	Agree	1 589	54.3
	Strongly Agree	241	8.2
	Total	2 797	95.7
	Missing	127	4.3
	Total	2 924	100.0
NORWAY	Strongly Disagree	174	7.5
	Disagree	462	20.0
	Agree	1 347	58.4
	Strongly Agree	256	11.1
	Total	2 239	97.1
	Missing	68	2.9
	Total	2 307	100.0

A.11 The Frequency of “Treat Me Fairly” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Strongly Disagree	73	2.7
	Disagree	280	10.3
	Agree	1 382	50.9
	Strongly Agree	882	32.5
	Total	2 617	96.3
	Missing	100	3.7
	Total	2 717	100.0
JAPAN	Strongly Disagree	265	9.1
	Disagree	609	20.8
	Agree	1 653	56.5
	Strongly Agree	289	9.9
	Total	2 816	96.3
	Missing	108	3.7
	Total	2 924	100.0
NORWAY	Strongly Disagree	212	9.2
	Disagree	437	18.9
	Agree	1 328	57.6
	Strongly Agree	257	11.1
	Total	2 234	96.8
	Missing	73	3.2
	Total	2 307	100.0

A.12 The Frequency of “Well With Students” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Strongly Disagree	178	6.6
	Disagree	645	23.7
	Agree	1 404	51.7
	Strongly Agree	397	14.6
	Total	2 624	96.6
	Missing	93	3.4
	Total	2 717	100.0
JAPAN	Strongly Disagree	301	10.3
	Disagree	946	32.4
	Agree	1 406	48.1
	Strongly Agree	178	6.1
	Total	2 831	96.8
	Missing	93	3.2
	Total	2 924	100.0
NORWAY	Strongly Disagree	231	10.0
	Disagree	586	25.4
	Agree	1 276	55.3
	Strongly Agree	163	7.1
	Total	2 256	97.8
	Missing	51	2.2
	Total	2 307	100.0

A.13 The Frequency of “Noise and Disorder” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Never	210	7.7
	Some Lessons	1 295	47.7
	Most Lessons	571	21.0
	Every Lesson	460	16.9
	Total	2 536	93.3
	Missing	181	6.7
	Total	2 717	100.0
JAPAN	Never	971	33.2
	Some Lessons	1 366	46.7
	Most Lessons	280	9.6
	Every Lesson	197	6.7
	Total	2 814	96.2
	Missing	110	3.8
	Total	2 924	100.0
NORWAY	Never	131	5.7
	Some Lessons	1 198	51.9
	Most Lessons	597	25.9
	Every Lesson	603	13.3
	Total	2 232	96.7
	Missing	75	3.3
	Total	2 307	100.0

A.14 The Frequency of “Doing Nothing” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Never	333	12.3
	Some Lessons	1 018	37.5
	Most Lessons	552	20.3
	Every Lesson	689	25.4
	Total	2 592	95.4
	Missing	125	4.6
	Total	2 717	100.0
JAPAN	Never	785	26.8
	Some Lessons	1 304	44.6
	Most Lessons	350	12.0
	Every Lesson	374	12.8
	Total	2 813	96.2
	Missing	111	3.8
	Total	2 924	100.0
NORWAY	Never	104	4.5
	Some Lessons	829	35.9
	Most Lessons	748	32.4
	Every Lesson	557	24.1
	Total	2 238	97.0
	Missing	69	3.0
	Total	2 307	100.0

A.15 The Frequency of “Students Don’t Start” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Never	240	8.8
	Some Lessons	1 321	48.6
	Most Lessons	701	25.8
	Every Lesson	307	11.3
	Total	2 569	94.6
	Missing	148	5.4
	Total	2 717	100.0
JAPAN	Never	973	33.3
	Some Lessons	1 298	44.4
	Most Lessons	299	10.2
	Every Lesson	198	6.8
	Total	2 768	94.7
	Missing	156	5.3
	Total	2 924	100.0
NORWAY	Never	182	7.9
	Some Lessons	1 301	56.4
	Most Lessons	536	23.2
	Every Lesson	222	9.6
	Total	2 241	97.1
	Missing	66	2.9
	Total	2 307	100.0

A.16 The Frequency of “Students Don’t Listen” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Never	205	7.5
	Some Lessons	1 594	58.7
	Most Lessons	598	22.0
	Every Lesson	178	6.6
	Total	2 575	94.8
	Missing	142	5.2
	Total	2 717	100.0
JAPAN	Never	773	26.4
	Some Lessons	1 526	52.2
	Most Lessons	314	10.7
	Every Lesson	181	6.2
	Total	2 794	95.6
	Missing	130	4.4
	Total	2 924	100.0
NORWAY	Never	162	7.0
	Some Lessons	1 448	62.8
	Most Lessons	471	20.4
	Every Lesson	157	6.8
	Total	2 238	97.0
	Missing	69	3.0
	Total	2 307	100.0

A.17 The Frequency of “Teachers Wait Long Time” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Never	195	7.2
	Some Lessons	1 482	54.5
	Most Lessons	603	22.2
	Every Lesson	347	12.8
	Total	2 627	96.7
	Missing	90	3.3
	Total	2 717	100.0
JAPAN	Never	1 210	41.4
	Some Lessons	1 363	46.6
	Most Lessons	155	5.3
	Every Lesson	102	3.5
	Total	2 830	96.8
	Missing	94	3.2
	Total	2 924	100.0
NORWAY	Never	118	5.1
	Some Lessons	1 194	51.8
	Most Lessons	723	31.3
	Every Lesson	236	10.2
	Total	2 271	98.4
	Missing	36	1.6
	Total	2 307	100.0

A.18 The Frequency of "Students Cannot Work Well" with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Never	320	11.8
	Some Lessons	1 608	59.2
	Most Lessons	499	18.4
	Every Lesson	146	5.4
	Total	2 573	94.7
	Missing	144	5.3
	Total	2 717	100.0
JAPAN	Never	636	21.8
	Some Lessons	1 516	51.8
	Most Lessons	402	13.7
	Every Lesson	197	6.7
	Total	2 751	94.1
	Missing	173	5.9
	Total	2 924	100.0
NORWAY	Never	146	6.3
	Some Lessons	1 564	67.8
	Most Lessons	409	17.7
	Every Lesson	115	5.0
	Total	2 234	96.8
	Missing	73	3.2
	Total	2 307	100.0

A.19 The Frequency of "Just Talking" with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Never of Hardly Ever	254	9.3
	A Few Times a Year	390	14.4
	About Once a Month	39	1.4
	Several Times a Month	278	10.2
	Several Times a Week	1 590	58.5
	Total	2 551	93.9
	Missing	166	6.1
	Total	2 717	100.0
JAPAN	Never of Hardly Ever	276	9.4
	A Few Times a Year	120	4.1
	About Once a Month	170	5.8
	Several Times a Month	562	19.2
	Several Times a Week	1 710	58.5
	Total	2 838	97.1
	Missing	86	2.9
	Total	2 924	100.0
NORWAY	Never of Hardly Ever	90	3.9
	A Few Times a Year	83	3.6
	About Once a Month	146	6.3
	Several Times a Month	476	20.6
	Several Times a Week	1 467	63.6
	Total	2 262	98.0
	Missing	45	2.0
	Total	2 307	100.0

A.20 The Frequency of "Discuss Books" with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Never of Hardly Ever	447	16.5
	A Few Times a Year	652	24.0
	About Once a Month	132	4.9
	Several Times a Month	286	10.5
	Several Times a Week	985	36.3
	Total	2 502	92.1
	Missing	215	7.9
	Total	2 717	100.0
JAPAN	Never of Hardly Ever	427	14.6
	A Few Times a Year	243	8.3
	About Once a Month	344	11.8
	Several Times a Month	691	23.6
	Several Times a Week	1 123	38.4
	Total	2 828	96.7
	Missing	96	3.3
	Total	2 924	100.0
NORWAY	Never of Hardly Ever	349	15.1
	A Few Times a Year	588	25.5
	About Once a Month	437	18.9
	Several Times a Month	509	22.1
	Several Times a Week	379	16.4
	Total	2 262	98.0
	Missing	45	2.0
	Total	2 307	100.0

A.21 The Frequency of "Discuss School Problems" with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Never of Hardly Ever	111	4.1
	A Few Times a Year	321	11.8
	About Once a Month	71	2.6
	Several Times a Month	319	11.7
	Several Times a Week	1 746	64.3
	Total	2 568	94.5
	Missing	149	5.5
	Total	2 717	100.0
JAPAN	Never of Hardly Ever	394	13.5
	A Few Times a Year	292	10.0
	About Once a Month	420	14.4
	Several Times a Month	678	23.2
	Several Times a Week	1 040	35.6
	Total	2 824	96.6
	Missing	100	3.4
	Total	2 924	100.0
NORWAY	Never of Hardly Ever	80	3.5
	A Few Times a Year	217	9.4
	About Once a Month	373	16.2
	Several Times a Month	689	29.9
	Several Times a Week	905	39.2
	Total	2 264	98.1
	Missing	43	1.9
	Total	2 307	100.0

A.22 The Frequency of "Eat Main Meal" with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Never of Hardly Ever	139	5.1
	A Few Times a Year	211	7.8
	About Once a Month	28	1.0
	Several Times a Month	96	3.5
	Several Times a Week	2 040	75.1
	Total	2 514	92.5
	Missing	203	7.5
	Total	2 717	100.0
JAPAN	Never of Hardly Ever	73	2.5
	A Few Times a Year	31	1.1
	About Once a Month	50	1.7
	Several Times a Month	248	8.5
	Several Times a Week	2 420	82.8
	Total	2 822	96.5
	Missing	102	3.5
	Total	2 924	100.0
NORWAY	Never of Hardly Ever	41	1.8
	A Few Times a Year	27	1.2
	About Once a Month	44	1.9
	Several Times a Month	169	7.3
	Several Times a Week	1 989	86.2
	Total	2 270	98.4
	Missing	37	1.6
	Total	2 307	100.0

A.23 The Frequency of "How Often Use Computers" with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Never of Hardly Ever	1 678	61.8
	A Few Times a Year	266	9.8
	About Once a Month	157	5.8
	Several Times a Month	191	7.0
	Several Times a Week	142	5.2
	Total	2 434	89.6
	Missing	283	10.4
	Total	2 717	100.0
JAPAN	Never of Hardly Ever	1 773	60.6
	A Few Times a Year	302	10.3
	About Once a Month	137	4.7
	Several Times a Month	224	7.7
	Several Times a Week	389	13.3
	Total	2 825	96.6
	Missing	99	3.4
	Total	2 924	100.0
NORWAY	Never of Hardly Ever	256	11.1
	A Few Times a Year	485	21.0
	About Once a Month	504	21.8
	Several Times a Month	598	25.9
	Several Times a Week	395	17.1
	Total	2 238	97.0
	Missing	69	3.0
	Total	2 307	100.0

A.24 The Frequency of "How Often Use Calculators" with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Never of Hardly Ever	1 134	41.7
	A Few Times a Year	462	17.0
	About Once a Month	210	7.7
	Several Times a Month	317	11.7
	Several Times a Week	327	12.0
	Total	2 450	90.2
	Missing	267	9.8
	Total	2 717	100.0
JAPAN	Never of Hardly Ever	1 759	60.2
	A Few Times a Year	236	8.1
	About Once a Month	159	5.4
	Several Times a Month	258	8.8
	Several Times a Week	413	14.1
	Total	2 825	96.6
	Missing	99	3.4
	Total	2 924	100.0
NORWAY	Never of Hardly Ever	52	2.3
	A Few Times a Year	49	2.1
	About Once a Month	120	5.2
	Several Times a Month	455	19.7
	Several Times a Week	1 556	67.4
	Total	2 232	96.7
	Missing	75	3.3
	Total	2 307	100.0

A.25 The Frequency of "How Often Use School Library" with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Never of Hardly Ever	557	20.5
	A Few Times a Year	805	29.6
	About Once a Month	449	16.5
	Several Times a Month	468	17.2
	Several Times a Week	281	10.3
	Total	2 560	94.2
	Missing	157	5.8
	Total	2 717	100.0
JAPAN	Never of Hardly Ever	1 442	49.3
	A Few Times a Year	618	21.1
	About Once a Month	325	11.1
	Several Times a Month	279	9.5
	Several Times a Week	169	5.8
	Total	2 833	96.9
	Missing	91	3.1
	Total	2 924	100.0
NORWAY	Never of Hardly Ever	455	19.7
	A Few Times a Year	700	30.3
	About Once a Month	551	23.9
	Several Times a Month	408	17.7
	Several Times a Week	112	4.9
	Total	2 226	96.5
	Missing	81	3.5
	Total	2 307	100.0

A.26 The Frequency of “Done Well” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Disagree	463	17.0
	Disagree Somewhat	592	21.8
	Agree Somewhat	814	30.0
	Agree	500	18.4
	Total	2 369	87.2
	Missing	348	12.8
	Total	2 717	100.0
NORWAY	Disagree	670	29.0
	Disagree Somewhat	525	22.8
	Agree Somewhat	537	23.3
	Agree	421	18.2
	Total	2 153	93.3
	Missing	154	6.7
	Total	2 307	100.0

A.27 The Frequency of “Good Marks Math” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Disagree	355	13.1
	Disagree Somewhat	481	17.7
	Agree Somewhat	1 005	37.0
	Agree	576	21.2
	Total	2 417	89.0
	Missing	300	11.0
	Total	2 717	100.0
NORWAY	Disagree	519	22.5
	Disagree Somewhat	466	20.2
	Agree Somewhat	693	.30.0
	Agree	477	20.7
	Total	2 155	93.4
	Missing	152	6.6
	Total	2 307	100.0

A.28 The Frequency of “Math Best” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Disagree	581	21.4
	Disagree Somewhat	606	22.3
	Agree Somewhat	692	25.5
	Agree	504	18.5
	Total	2 383	87.7
	Missing	334	12.3
	Total	2 717	100.0
NORWAY	Disagree	799	34.6
	Disagree Somewhat	509	22.1
	Agree Somewhat	442	19.2
	Agree	410	17.8
	Total	2 160	93.6
	Missing	147	6.4
	Total	2 307	100.0

A.29 The Frequency of “Math Fun” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Disagree	448	16.5
	Disagree Somewhat	496	18.3
	Agree Somewhat	853	31.4
	Agree	630	23.2
	Total	2 427	89.3
	Missing	290	10.7
	Total	2 717	100.0
NORWAY	Disagree	759	32.9
	Disagree Somewhat	496	21.5
	Agree Somewhat	556	24.1
	Agree	357	15.5
	Total	2 168	94.0
	Missing	139	6.0
	Total	2 307	100.0

A.30 The Frequency of “Math Important” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Disagree	91	3.3
	Disagree Somewhat	175	6.4
	Agree Somewhat	940	34.6
	Agree	1 167	43.0
	Total	2 373	87.3
	Missing	344	12.7
	Total	2 717	100.0
NORWAY	Disagree	678	29.4
	Disagree Somewhat	569	24.7
	Agree Somewhat	574	24.9
	Agree	323	14.0
	Total	2 144	92.9
	Missing	163	7.1
	Total	2 307	100.0

A.31 The Frequency of “Math Absorbed” with respect to Countries

	Alternatives	Frequency	Percent
BRAZIL	Disagree	224	8.2
	Disagree Somewhat	216	7.9
	Agree Somewhat	1 200	44.2
	Agree	810	29.8
	Total	2 450	90.2
	Missing	267	9.8
	Total	2 717	100.0
NORWAY	Disagree	823	35.7
	Disagree Somewhat	522	22.6
	Agree Somewhat	579	25.1
	Agree	262	11.4
	Total	2 186	94.8
	Missing	121	5.2
	Total	2 307	100.0

APPENDIX B

THE SIMPLIS SYNTAX FOR THE MATHEMATICAL LITERACY MODEL FOR BRAZIL

Observed Variables

FAVHOBBY FEELHAPP ENJOYLIB TALKBOOK REHAVETO FEWMINUT WASTETIM LISTENME INTEREST EXTRHELP TREAFAIR WELLSTUD NOISE NOTHING NOTSTART NOLISTEN LONGTIME NOWORKWE JUSTTALK DISCUSSB DISCUSSP MAINMEAL USECOMPU CALCULAT SCHOOLIB MDONEWEL MGOODMAR MATHBEST MATHFUN MATHIMPO MABSORBE PV1MATH PV2MATH PV3MATH PV4MATH PV5MATH PV1READ PV2READ PV3READ PV4READ PV5READ

Covariance Matrix from file: Brazil.cov

Sample Size = 1682

Latent Variables ATTREAD RELATION CLIMATE COM USAGE ATTMATH MATHLIT READLIT

Relationships

FAVHOBBY FEELHAPP ENJOYLIB TALKBOOK REHAVETO FEWMINUT WASTETIM SCHOOLIB = ATTREAD

LISTENME INTEREST EXTRHELP TREAFAIR WELLSTUD = RELATION

NOISE NOTHING NOTSTART NOLISTEN LONGTIME NOWORKWE = CLIMATE

JUSTTALK DISCUSSB DISCUSSP MAINMEAL = COM

USECOMPU CALCULAT SCHOOLIB = USAGE

MDONEWEL MGOODMAR MATHBEST MATHFUN MATHIMPO MABSORBE = ATTMATH
PV1MATH PV2MATH PV3MATH PV4MATH PV5MATH = MATHLIT
PV1READ PV2READ PV3READ PV4READ PV5READ = READLIT
MATHLIT = ATTREAD CLIMATE USAGE ATTMATH
READLIT = ATTREAD RELATION CLIMATE COM USAGE
ATTMATH =MATHLIT
MATHLIT = READLIT

Set Error Covariance of NOWORKWE and NOLISTEN Free
Set Error Covariance of WASTETIM and FEWMINUT Free
Set Error Covariance of PV5MATH and PV5READ Free
Set Error Covariance of PV4MATH and PV4READ Free
Set Error Covariance of MGOODMAR and MDONEWEL Free
Set Error Covariance of PV3MATH and PV3READ Free
Set Error Covariance of NOLISTEN and NOTSTART Free
Set Error Covariance of PV1MATH and PV1READ Free
Set Error Covariance of PV2MATH and PV2READ Free
Set Error Covariance of NOWORKWE and NOTSTART Free
Set Error Covariance of MAINMEAL and JUSTTALK Free
Set Error Covariance of FEWMINUT and REHAVETO Free
Set Error Covariance of WASTETIM and REHAVETO Free
Set Error Covariance of MATHIMPO and MATHFUN Free
Set Error Covariance of MABSORBE and MATHIMPO Free

Path Diagram
Admissibility Check = 1000
Iterations = 5000
Method of Estimation: Maximum Likelihood
Lisrel Output: EF

End of Problem

THE SIMPLIS SYNTAX FOR THE MATHEMATICAL LITERACY MODEL FOR JAPAN

Observed Variables
FAVHOBBY FEELHAPP ENJOYLIB TALKBOOK REHAVETO FEWMINUT WASTETIM LISTENME INTEREST EXTRHELP TREAFAIR WELLSTUD NOISE NOTHING NOTSTART NOLISTEN LONGTIME NOWORKWE JUSTTALK DISCUSSB DISCUSSP MAINMEAL USECOMPU CALCULAT SCHOOLIB PV1MATH PV2MATH PV3MATH PV4MATH PV5MATH PV1READ PV2READ PV3READ PV4READ PV5READ
Covariance Matrix from file: Japan.cov

Sample Size = 2476
Latent Variables ATTREAD RELATION CLIMATE COM USAGE MATHLIT READLIT

Relationships
FAVHOBBY FEELHAPP ENJOYLIB TALKBOOK REHAVETO FEWMINUT WASTETIM SCHOOLIB = ATTREAD
LISTENME INTEREST EXTRHELP TREAFAIR WELLSTUD = RELATION
NOISE NOTHING NOTSTART NOLISTEN LONGTIME NOWORKWE = CLIMATE
JUSTTALK DISCUSSB DISCUSSP MAINMEAL = COM
USECOMPU CALCULAT SCHOOLIB = USAGE
PV1MATH PV2MATH PV3MATH PV4MATH PV5MATH = MATHLIT
PV1READ PV2READ PV3READ PV4READ PV5READ = READLIT
MATHLIT = ATTREAD CLIMATE USAGE
READLIT = ATTREAD RELATION CLIMATE COM USAGE
MATHLIT = READLIT

Set Error Covariance of NOWORKWE and NOLISTEN Free

Set Error Covariance of WASTETIM and FEWMINUT Free

Set Error Covariance of PV5MATH and PV5READ Free

Set Error Covariance of PV4MATH and PV4READ Free

Set Error Covariance of PV3MATH and PV3READ Free

Set Error Covariance of NOLISTEN and NOTSTART Free

Set Error Covariance of PV1MATH and PV1READ Free

Set Error Covariance of PV2MATH and PV2READ Free

Set Error Covariance of NOWORKWE and NOTSTART Free

Set Error Covariance of MAINMEAL and JUSTTALK Free

Set Error Covariance of FEWMINUT and REHAVETO Free

Set Error Covariance of WASTETIM and REHAVETO Free

Path Diagram

Admissibility Check = 1000

Iterations = 5000

Method of Estimation: Maximum Likelihood

Lisrel Output: EF

End of Problem

THE SIMPLIS SYNTAX FOR THE MATHEMATICAL LITERACY MODEL FOR NORWAY

Observed Variables
FAVHOBBY FEELHAPP ENJOYLIB TALKBOOK REHAVETO FEWMINUT WASTETIM LISTENME INTEREST EXTRHELP TREAFAIR WELLSTUD NOISE NOTHING NOTSTART NOLISTEN LONGTIME NOWORKWE JUSTTALK DISCUSSB DISCUSSP MAINMEAL USECOMPU CALCULAT SCHOOLIB MDONEWEL MGOODMAR MATHBEST MATHFUN MATHIMPO MABSORBE PV1MATH PV2MATH PV3MATH PV4MATH PV5MATH PV1READ PV2READ PV3READ PV4READ PV5READ
Covariance Matrix from file: Norway.cov

Sample Size = 1770
Latent Variables ATTREAD RELATION CLIMATE COM USAGE ATTMATH MATHLIT READLIT

Relationships
FAVHOBBY FEELHAPP ENJOYLIB TALKBOOK REHAVETO FEWMINUT WASTETIM SCHOOLIB = ATTREAD
LISTENME INTEREST EXTRHELP TREAFAIR WELLSTUD = RELATION
NOISE NOTHING NOTSTART NOLISTEN LONGTIME NOWORKWE = CLIMATE
JUSTTALK DISCUSSB DISCUSSP MAINMEAL = COM
USECOMPU CALCULAT SCHOOLIB = USAGE
MDONEWEL MGOODMAR MATHBEST MATHFUN MATHIMPO MABSORBE = ATTMATH
PV1MATH PV2MATH PV3MATH PV4MATH PV5MATH = MATHLIT
PV1READ PV2READ PV3READ PV4READ PV5READ = READLIT
MATHLIT = ATTREAD CLIMATE USAGE ATTMATH
READLIT = ATTREAD RELATION CLIMATE COM USAGE
ATTMATH = MATHLIT
MATHLIT = READLIT

Set Error Covariance of NOWORKWE and NOLISTEN Free
Set Error Covariance of WASTETIM and FEWMINUT Free
Set Error Covariance of PV5MATH and PV5READ Free
Set Error Covariance of PV4MATH and PV4READ Free
Set Error Covariance of MGOODMAR and MDONEWEL Free
Set Error Covariance of PV3MATH and PV3READ Free
Set Error Covariance of NOLISTEN and NOTSTART Free
Set Error Covariance of PV1MATH and PV1READ Free
Set Error Covariance of PV2MATH and PV2READ Free
Set Error Covariance of NOWORKWE and NOTSTART Free
Set Error Covariance of MAINMEAL and JUSTTALK Free
Set Error Covariance of FEWMINUT and REHAVETO Free
Set Error Covariance of WASTETIM and REHAVETO Free
Set Error Covariance of MATHIMPO and MATHFUN Free
Set Error Covariance of MABSORBE and MATHIMPO Free

Path Diagram
Admissibility Check = 1000
Iterations = 5000
Method of Estimation: Maximum Likelihood
Lisrel Output: EF

End of Problem

APPENDIX C

LISREL ESTIMATES OF PARAMETERS IN MEASUREMENT MODELS FOR BRAZIL, JAPAN AND NORWAY

Appendix C includes the LISREL estimates of parameters in measurement model of Brazil with coefficients in standardized value, the LISREL estimates of parameters in measurement model of Brazil with coefficients in t-values, the LISREL estimates of parameters in measurement model of Japan with coefficients in standardized value, the LISREL estimates of parameters in measurement model of Japan with coefficients in t-values, the LISREL estimates of parameters in measurement model of Norway with coefficients in standardized value, and the LISREL estimates of parameters in measurement model of Norway with coefficients in t-values.

APPENDIX D

GOODNESS-OF-FIT CRITERIA FOR THE MODELS OF BRAZIL, JAPAN AND NORWAY

Goodness-of-Fit Criteria	Brazil	Japan	Norway
Chi-Square (χ^2), df	2678.78; 742	2514.77; 528	3610.44; 742
Normed Chi-Square (NC)	3.61	4.76	4.87
Goodness-of-Fit Index (GFI)	0.93	0.95	0.91
Adjusted Goodness-of-Fit Index (AGFI)	0.92	0.93	0.89
Root-Mean-Square Residual (RMR)	0.071	0.046	0.068
Root-Mean-Squared Error of Approximation (RMSEA)	0.039	0.039	0.047
Normed Fit Index (NFI)	0.95	0.97	0.94
Non-Normed Fit Index (NNFI)	0.96	0.97	0.95
Comparative Fit Index (CFI)	0.96	0.97	0.95
Incremental Fit Index (IFI)	0.96	0.97	0.95
Relative Fit Index (RFI)	0.94	0.96	0.94
Expected Cross Validation Index (ECVI)	1.74	1.10	2.18
Parsimonious Normed Fit Index (PNFI)	0.86	0.86	0.85
Parsimonious Goodness-of-Fit Index (PGFI)	0.80	0.79	0.78