A STRUCTURAL EQUATION MODELING STUDY: FACTORS RELATED TO MATHEMATICS AND GEOMETRY ACHIEVEMENT ACROSS GRADE LEVELS

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SEMİRHAN GÖKÇE

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Prof. Dr. Canan Özgen
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Prof. Dr. Ömer Geban
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Prof. Dr. Giray Berberoğlu
Supervisor

Examining Committee Members

Prof. Dr. Gül AYDIN	(METU, EDS)	
Prof. Dr. Giray BERBEROĞLU	(METU, SSME)	
Prof. Dr. Petek AŞKAR	(H.U. , CEIT)	
Prof. Dr. Ömer GEBAN	(METU, SSME)	
Assoc. Prof. Dr. Safure BULUT	(METU, SSME)	

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Name, Last name : Semirhan GÖKÇE

Signature :

ABSTRACT

A STRUCTURAL EQUATION MODELING STUDY:
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ACHIEVEMENT ACROSS GRADE LEVELS

GÖKÇE, Semirhan

M.S., Department of Secondary Science and Mathematics Education

Supervisor: Prof. Dr. Giray Berberoğlu

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The factors related to mathematics and geometry achievement were modeled in this study. It was based on the data obtained from the Student Assessment Program carried out by Ministry of National Education. Mathematics achievement tests and student questionnaires of each grade were analyzed by using principal component analysis to obtain different dimensions that are expected to be related with student achievement. Before the principal component analysis, a content based evaluation of the content of the mathematics achievement tests was actualized and the items were grouped as mathematics and geometry. Regarding the student questionnaire socio-economic status, perception of success and interest toward mathematics and science, student-centered activities and teacher-centered activities in the classroom were identified as factors through the principal component analysis. Thereafter, three models were designed and tested by structural equation modeling technique (SEM) using LISREL 8.54. Path analysis with latent variables was used for testing the models. The following results were obtained in the study. In all of the models, socioeconomic status had a positive impact on the mathematics and geometry achievement of the students for all the grade levels examined. Teacher centered activities were found to be positively related with the students' success of mathematics and geometry. On the other hand, student centered activities intended to have a negative relation with mathematics and geometry achievement. As the other variables were considered, an increase on the mathematics and geometry scores of the students' was observed in all grade levels with the increase in the perception of success and interest toward mathematics and science.

Keywords: Mathematics and Geometry Achievement, Structural Equation Modeling, Socioeconomic Status, Teacher and Student Centered Activities, Perception of Success and Interest.

ÖZ

BİR YAPISAL DENKLEM MODELLEME ÇALIŞMASI:
SINIF DÜZEYLERİNDE MATEMATİK VE GEOMETRİ BAŞARISI İLE İLGİLİ FAKTÖRLER

GÖKÇE, Semirhan

Yüksek Lisans, Ortaöğretim Fen ve Matematik Alanları Eğitimi Bölümü

Tez Yöneticisi: Prof. Dr. Giray Berberoğlu

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Bu çalışmada öğrencilerin matematik ve geometri başarısı ile ilgili faktörler modellenmiş olup, Milli Eğitim Bakanlığı tarafından gerçekleştirilen Öğrenci Başarısının Belirlenmesi Sınavı (ÖBBS-2002) verileri kullanılmıştır. Öğrenci başarısı ile ilgili olduğu düşünülen herbir sınıf düzeyine ait boyutlara ulaşmak için matematik başarı testi ve öğrenci anketlerine ayrı ayrı temel bileşenler analizi uygulanmıştır. Çalışmaya başlamadan önce, matematik başarı testlerindeki soruların içerikleri temel alınarak ayrıştırılmış, matematik ve geometri soruları olmak üzere iki farklı gruba ayrılmıştır. Öğrenci anketi dikkate alındığında ise; sosyoekonomik düzey, matematik ve fen derslerine yönelik başarı ve ilgi algısı, öğrenci merkezli sınıf içi etkinlikleri ile öğretmen merkezli sınıf içi etkinlikleri temel bileşenler analizi sonuçlarından elde edilen değişkenlerdir. Daha sonra, üç model tasarlanmış ve yapısal denklem modelleme tekniği kullanılarak LISREL 8.54 programı ile test edilmiştir. Modellerin test edilmesinde örtük değişkenli path analizi kullanılmıştır. Çalışmada aşağıdaki sonuçlara ulaşılmıştır. Oluşturulan modellerde sosyoekonomik düzey tüm sınıf düzeylerinde matematik ve geometri başarısına olumlu bir etki yapmaktadır. Öğretmen merkezli aktiviteler ile öğrencilerin matematik ve geometri başarısı arasında olumlu bir ilişki olduğu saptanmıştır. Diğer yandan, öğrenci merkezli aktiviteler ile matematik ve geometri başarısı arasında olumsuz bir ilişki bulunmuştur. Diğer değişkenler ele alındığında ise, matematik ve fen derslerine yönelik başarı ve ilgi algısının artmasıyla, tüm sınıf düzeylerindeki matematik ve geometri puanlarının da arttığı gözlemlenmiştir.

Anahtar Kelimeler: Matematik ve Geometri Başarısı, Yapısal Denklem Modellemesi, Sosyoekonomik Düzey, Öğretmen Merkezli Etkinlikler, Öğrenci Merkezli Etkinlikler, İlgi ve Başarı Algısı.

To my parents, brother, sister, grandmother and grandfather

for all …

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SES	: Socio-Economic Status
TEA_CENT	: Teacher Centered Activities
STU_CENT	: Student Centered Activities
INT_SUC	: Perception of Success and Interest towards Mathematics and Science
MATH_ACH	: Mathematics Achievement
GEO_ACH	: Geometry Achievement
GFI	: Goodness of Fit Index
AGFI	: Adjusted Goodness of Fit Index
RMSEA	: Root Mean Square Error of Approximation
S-RMR	: Standardized Root Mean Square Residual
ERDD	: Educational Research and Development Directorate
MONE	: Ministry of National Education
SAP	: Student Assessment Program
TIMSS	: Third International Mathematics and Science Study

CHAPTER 1

INTRODUCTION

This study aims identifying the factors related to mathematics and geometry achievement across grade levels through the use of data from the Student Assessment Program-2002 (Öğrenci Başarısının Belirlenmesi Sınavı - ÖBBS 2002) conducted by the Ministry of National Education (MONE). It also models the factors to observe their relation to the students' mathematics and geometry achievement.

Indeed, many surveys were conducted on international ground to evaluate the mathematics achievement during the past decade. One of the major projects conducted in this field was Third International Mathematics and Science Study (TIMSS). It was prepared by International Association for The Evaluation of Educational Achievement. Over half a million students from more than 15,000 schools of 41 countries took part in TIMSS. The tests in TIMSS were designed in English and rigorously translated into 30 languages (Mullis, 1997). TIMSS mathematics achievement test results were converted to a scale of mean as 500 and standard deviation as 100. Although the international average of the study was 487, Turkey had an average of 429 which was below the international average (National TIMSS Report, 2003).

Likewise, a similar study like TIMSS was conducted in Turkey in 2002 which was named as the Student Assessment Program by the MONE. These studies clearly have indicated that students' achievement level is far behind the expected levels in Turkey, in mathematics and science. Thus, investigating the factors that are related to low achievement levels of students might have a value to propose concrete policy implementations to enhance the quality of the educational outcomes in Turkey. The detailed information about the Student Assessment Program (SAP-2002) is documented below.

1.1 The Student Assessment Program by MONE

The Student Assessment Program was a national survey created by Ministry of National Education (MONE). It was conducted in 2002 in order not to rank the schools, teachers and the students but to boost their success by taking the measures. The Student Assessment Program was prepared by the three units of MONE which can be listed as follows: General Directorate of Primary Education, General Directorate of Educational Technologies and Educational Research and Development Directorate (ERDD). During the application of the survey, 48 consultants of ERDD and approximately 6900 teachers of MONE participate (Educational Research and Development Directorate, 2005). All the measures were taken in order to get the standard conditions. Seminars were given to the teachers and consultants about the general rules and the directions to be applied in the study.

The major goals of Student Assessment Program can be listed as follows:

- Evaluating the students' Turkish, mathematics, science and social sciences achievement across grade levels according to gender and regions.
- Constituting a starting point to observe the development of students' success for different age groups and grade levels.

- Obtaining information about the socioeconomic status, classroom activities, perception of success and interest towards Turkish, mathematics, science and social sciences and spare time activities (Educational Research and Development Directorate, 2005).

The Student Assessment Program was applied to 112,000 students from different grade levels: 4^{th} grade to 8^{th} grade. Stratified random sampling method was used to select the students from 573 primary schools of 7 regions in Turkey. The provinces of the regions were selected and included in the study to see whether they could represent the population or not. Not only the number of schools in provincials and city centers but also the number of students per school could be defined as the factors in determining the number of schools in each state. Board of Research, Planning and Coordination determined the provinces in regions and schools in provinces.

As far as the characteristics of the survey was concerned, it started with an achievement test containing multiple choice items including Turkish language and literature, social sciences, mathematics and science then followed by a 58-item-questionnaire. Beside the achievement of the students, the SAP-2002 data also had information about socio-economic status, taking private lesson frequency, time spent for homework, use of computers, perception of success, perception of interest, student centered activities, use of technology in classroom, spare time activities, private tutoring and beliefs on examinations etc. Interpretation of achievement data and the information included in student questionnaire might help researchers to understand the factors that were influential on achievement of the student.

Two types of booklets for achievement tests of each grade level were used in the study. Booklet A and Booklet B consisted of the parallel items. In other words, the subject and the skill levels of the corresponding items in each booklet were almost the same. Moreover, in order to balance the test items and observe the developments of grade levels, same questions were placed in the achievement tests.

1.2 Research Question of the Study

Research question of this study is: “What are the general models that cover the factors related to the students’ mathematics and geometry achievement across grade levels regarding the Student Assessment Program–2002 (SAP-2002) data set?” In relation to this question, the answer for the question of “Can the proposed models describe the mathematics achievements similarly across 6^{th}, 7^{th} and 8^{th} grade levels?” was sought for as well in the present study.

In this study, exploratory factor analyses were carried out to select the variables that would be included in the model. For this reason, items of the both student questionnaire and the achievement test were analyzed throughout the Principal Component Analysis to form the latent variables included in the model.

1.3 Purpose of the Study

The factors that were related to students’ mathematics and geometry achievement were first analyzed and then tested within the framework of the model presented in Figure 1.1. Three models of the different grade levels (6^{th}, 7^{th} and 8^{th} grades) were tested during the study. Each model consisted of the factors related to the achievement of the students and were selected from the analysis of the questionnaire items. During the analysis of the study, the same factors were retained across the grade levels.

H_o: The model between SES, INT_SUC, TEA_CENT and STU_CENT is not statistically significant.

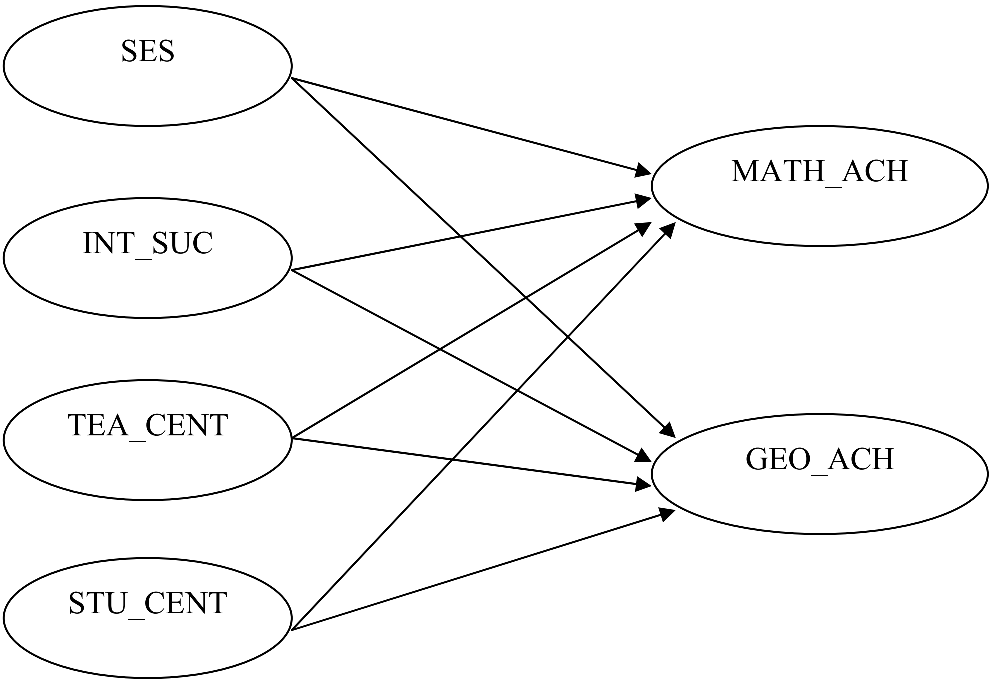

Figure 1.1 Hypothesized Mathematics and Geometry Achievement Model

Structural Equation Modeling is a group of statistical techniques which incorporates and integrates path analysis and factor analysis. Path analysis is an extension of the regression model, used to test the fit the models which are being compared by the researcher. On the other hand, factor analysis is used to uncover the dimensions of a set of variables. It reduces attribute space from a larger number of variables to a smaller number of factors (NC State University, Humanities and Social Sciences).

In this hypothesized model; socioeconomic status (SES), perception of success and interest toward mathematics and science (INT_SUC), teacher-centered classroom activities (TEA_CENT) and student-centered classroom activities (STU_CENT) were selected as the variables of the study. These variables were supported by the previous studies.

1. Socioeconomic Status (SES)

Socioeconomic status (SES) of a family was one of the most important factors related to student achievement (Coleman, 1966). According to Schiller et al. (2002), families having high socioeconomic status generally had much more success in preparing their children for school since they promoted and supported their children's success and academic development. Kalender (2004) summarized socioeconomic status as parental education level, number of books and number of siblings. In SAP-2002, the students were asked to indicate their information about mother's education level, father's education level, number of books at home, number of siblings and facilities at home.

2. Perception of Success and Interest toward Mathematics and Science (INT_SUC)

Perception of success and interest toward mathematics and science was considered as one of the most important factors on students' achievement. (Kalender, 2004). Moreover, according to Berberoğlu et al. (2003) perception of success was a variable in defining the students' mathematics achievement. In addition, Papanastasiou (2000) investigated the positive relationship between positive attitudes toward mathematics and mathematics achievement. Therefore, perception of success and interest toward mathematics and science was included in the study as a latent variable. In the student questionnaire students were asked to fill out their interest and success toward mathematics and science. These items were taken as the observed variables.

3. Teacher-Centered Classroom Activities (TEA_CENT)

Teacher centered classroom activities were decided as a latent variable of this study. According to Kalender (2004), teacher was much more dominant as compared with the students in teacher-centered classroom activities. Students were mostly passive listeners. Turkish students generally preferred not to participate in the lesson. According to Yayan and Berberoğlu (2004) what teachers had done in the classroom was a crucial variable to explain the mathematics achievement. In the questionnaire, the existence of the classroom activities containing 'Lesson given by teacher', 'Solve sample exercises', 'Teacher gives daily life examples' …etc. made the researcher take the teacher-centered classroom activities as a variable to define mathematics achievement.

4. Student-Centered Classroom Activities (STU_CENT)

Student centered classroom activities were included in the study so as to compare them with teacher centered classroom activities. Moreover, it contained a set of activities in which the participation of students was supported in the classroom. Berberoğlu et al. (2003) investigated that student-centered classroom activities had a negative effect on mathematics achievement. During the study, student-centered classroom activities latent variable was formed by the following observed variables: "studying on a problem or a project with couples or as a group in mathematics lesson, discussing on completed homework etc." In the student questionnaire of the present study, similar items like "lesson given by students, student discussions, doing group work and discussion between teacher and students" were asked to the students. In international ground, Davidson (1985) reviewed 79 studies that compared student achievement in small group settings with traditional whole-class instruction. In almost all of the 79 experimental studies, students from student-centered classroom performed better.

In Turkey, the result of this study would be expected to show the effect of student centered classroom activities on Turkish students' mathematics and geometry achievement with survey data.

5. Mathematics and Geometry Achievement (MATH_ACH and GEO_ACH)

In SAP-2002 study, students were given an achievement test containing Turkish, mathematics, science and social sciences items. In the study, mathematics achievement test items were grouped into two parts: mathematics and geometry. Making this distinction would allow us to observe the effects of the latent dependent variables on mathematics achievement (MATH_ACH) and geometry achievement (GEO_ACH).

1.4 Significance of the Study

Mathematics achievement involved a complex interaction of factors that have direct effects and/or indirect effects. Although factors affecting mathematics achievement had been studied widely, it was important to explore the factors contributing to Turkish students' mathematics achievement according to the Student Assessment Program-2002 data. Ministry of National Education aimed to determine the success students considering gender and the region factors. In addition, recognizing and collecting information about socio-economic status (SES), perception of success, perception of interest and activities done in classroom could be identified as the other important aim of the study. The analysis of this survey would both evaluate the success of the program applied and help to develop the activities so as to increase the quality of education.

After the application of the Student Assessment Program-2002, Directorate of Educational Research and Development (EARGED) published a limited number of reports and booklets about the results of the achievement tests and student questionnaires. This study was an opportunity to identify the factors mathematics and geometry achievement of the education system. On the other hand, there were not enough studies concerning geometry achievement of the students in Turkey.

The results of this study would also be crucial in identifying the variables related to the geometry achievement. In addition, the results of the present study might bring an opportunity to identify the variables contributing students' learning. These findings would probably initiate some policy notes to improve student learning throughout the country.

CHAPTER 2

LITERATURE REVIEW

This chapter is concerned with the important points of the previous studies in the literature related to the present study. General information about the mathematics and geometry achievement in Turkish education system and studies containing the variables which are similar to the ones used in the current study are included in this chapter. In addition, previous structural equation modeling studies will also be mentioned in this part.

In the previous decade, many international studies like Third International Mathematics and Science Study (TIMSS), Program for International Student Assessment (PISA) and The Progress in International Reading Literacy Study (PIRLS) were conducted in many countries of the world. Turkey participated in PISA, PIRLS and some parts of TIMSS study conducted by International Association for The Evaluation of Educational Achievement. It was an international survey on mathematics and science education implementing repetitive data collection during the following the years. Although Turkey participated only in the 1999 TIMSS-R (Third International Mathematics and Science Study–Repeat), TIMSS was conducted first in 1995 with 42 participant countries and repeated in 1999 and 2003. According to the TIMSS-R results, Turkey's mathematics score was significantly below the international average (Gonzalez & Miles, 2001).

This result could help the policy makers to analyze the difficulties, and weaknesses of the Turkish students. In addition, many studies carried out on different country data according to the TIMSS data set (Bos and Kuiper, 1999; Yayan, 2003; Özdemir, 2003; Smyth, 2001) allow a comprehension of locating the factors affecting mathematics and science achievements.

Another international study on education was the Programme for International Student Assessment (PISA) which was carried out by Organization for Economic Co-operation and Development (OECD). It was jointly developed by participating countries and administered to15-year-olds in schools to measure whether the students had acquired some of the knowledge and skills which they would need in their life. The survey was implemented in 43 countries in the first assessment in 2000, in 41 countries in the second assessment in 2003 and at least 58 countries will participate in the third assessment in 2006 (PISA 2000 Technical Report). As far as the results were considered, the achievement level of Turkish students' was below the average (National Report, 2003).

The third and the last international study mentioned in the current research was the Progress in International Reading Literacy Study (PIRLS). PIRLS was the first in a continuing five-year cycle of studies in administering reading progress for the selected countries. PIRLS data collection took place in 2001 in 35 countries around the world. PIRLS, conducted under the auspices of the International Association for the Evaluation of Education (IEA), provided an important end point to obtain internationally comparative data about the fourth grade students' reading achievement (PIRLS International Report, 2001). National Report of PIRLS on the other hand, was published by Ministry of National Education (MONE) in June, 2003. According to the results of the report, Turkish students' reading abilities were 28th out of 35 participating countries.

2.1 Modeling

Kalender (2004) analyzed the science items of the Student Assessment Program-2002 (SAP-2002) study to explore the effects of socioeconomic status, experiments and technological material use, teacher-centered activities, student-centered activities, private tutoring and perception of interest and success on science achievement. The researcher used 29,952 students of 6^{th}, 7^{th} and 8^{th} grade students. Moreover, types of schools containing state primary schools, primary regional boarding schools, and private primary school were also included into the study. Path Analysis with Latent Variables was used to determine the effect of the factors. Results showed that socioeconomic status had a strong positive effect on all of the levels investigated. As far as teacher centered activities and student centered activities were concerned, the former had a positive and the latter had a negative effect on science achievement. Tutoring decreased the science achievement of 6^{th} grade students but increased the rest of investigated grade levels and school types. Although the effect of technology and material usage was not significant for 7^{th} and 8^{th} grade students, the factor had a negative effect on 6^{th} grade students. Finally, perception of interest and success had a strong effect on science achievement for all grade levels and school types.

İş (2003) modeled the data of Brazil, Japan and Norway in Programme for International Student Assessment (PISA) to obtain the factors affecting mathematical literacy of 15 years old students. Having different cultural settings was the main criteria to select these three countries. According to the study, mathematical literacy was stimulated by the factors of students themselves, the families and the school. Moreover, there was a reciprocal relationship between the attitudes towards mathematics and mathematical literacy.

Özdemir (2003) presented a linear structural model on the factors affecting the science achievement of Turkish students according to Third

International Mathematics and Science Study–Repeated (TIMSS-R) data. Student-centered activities, teacher-centered activities, socioeconomic status, perception of success, science enjoyment, and importance of science were the list of the latent variables to affect science achievement. Although perception of success and teacher centered activities had a positive effect on science achievement, student centered activities indicated a negative relationship with the students' science achievement. Socioeconomic status had the highest positive affect effect on achievement. According to the results, lessons containing student centered activities did not make any improvements on the students' success in Turkey.

2.2 Mathematics and Geometry Achievement

According to the Third International Mathematics and Science Study (TIMSS) data of Turkey, the Netherlands and Italy, Yayan (2003) investigated and compared the factors affecting mathematics achievement. The results of the study showed that although student-centered activities had a negative effect on mathematics achievement, socioeconomic status had a strong positive effect. One of the most important observations here was that teachers in Turkish Educations System lack qualifications to design and implement student centered classroom activities.

Cho (2002) discussed the factors affecting mathematics achievement according to Third International Mathematics and Science Study (TIMSS) data. The study compared success of students from United States and Korea. Structural Equation Modeling was conducted by LISREL. During the study, Cho grouped extra lesson, watching TV or video, expectant education level, etc. as *student background factor*; teacher's education level, importance of thinking creatively and importance of remembering formulas and procedures etc. as *teacher background factor*; mother education level, father education level, number of books at home, etc. as *home background factor*; and class size as *school characteristics*. The findings of the study showed that mathematics achievement of Korean students was positively affected by student background factor. On the other hand, home background factor had the strongest effect on American students. In addition, school characteristics and tutoring affected mathematics achievement positively in United States of America. However, these two variables had negative effect in Korea.

DeVaney (1996) examined the relationships between classroom mathematics achievement instructional practices and mathematics achievement. The measures of mathematics achievement used in this study include numbers, operations and geometry subscales. In the study, 147 teachers and 1032 students were selected from the 1992 Trial State Mathematics Assessment for Mississippi. The results of the study showed that the students having at least one parent having some post-high school education had higher ability in mathematics and geometry. In addition, classes with more positive attitudes were associated with higher computation and geometry scores.

Bos and Kuiper (1999) studied on Third International Mathematics and Science Study (TIMSS) data in order to analyze what the differences and similarities among the education systems of countries were. In the study, the researchers considered 8th grade students of ten countries containing eight Western and two Central European education systems and prepared models with the variables they gained from analysis. The latent variables contained in the model were: teaching style, attitude towards mathematics, school climate, mathematics lesson climate, student's gender, homework, maternal expectation, friends' expectation, success attribution toward mathematics, instructional formats, home educational background, class size, effective learning time, assessment and out-of-school activities. Teaching style had an indirect effect on mathematics achievement and attitude toward mathematics also affected achievement.

2.3 Socioeconomic Status

For decades, it has been assumed that socioeconomic status was one of the most important predictors of students' achievement. This idea was supported by Coleman (1966). Results indicated that Socioeconomic Status had a very important place in a student's achievement (Caldas & Bankston III, 1997). One of the most important factors in student's own inputs was Socioeconomic Status. Socioeconomic status (SES) was a term used to summarize a variety of factors, including parental education, occupation, and number of books etc. that influence student performance.

According to PISA 2003 report of National Center for Educational Statistics (NCES), socioeconomic status was measured by an index that includes information about the family structure, parental education and occupation, parental labour market participation, and whether family of the student's had specific facilities at home. In fact, analysis of PISA 2003 results showed that students from higher socioeconomic families tended to perform better in mathematics.

Berberoğlu et al. (2003) studied on TIMSS-R data of Turkey in order to determine the factors affecting students' mathematics and science achievement. During the study, parent's education level and number of books formed the socioeconomic status latent variable. One of the major findings of the study was that socioeconomic status had the greatest positive effect on achievement.

Most of the researchers stressed that degree of relationship between Socioeconomic Status and students' achievement was about 0.30 (Yang, 2003). Furthermore, Baker and Stevenson (1986) investigated that the parents with higher education levels shared their experiences with their children more. This was a good way of boosting the achievement level of the students.

The interaction between family characteristics and academic achievement was studied by Schiller et al. (2002). According to the results of the research, the effect of family structure had a strong effect on student achievement.

In another study, Muller and Kerbow (1993) stated that parents having higher education were tending to be more interested in their children's homework, courses, and school problems.

2.4 Teacher and Student Centered Instruction

In teacher centered instruction, the teacher's role was to present the information that was to be learned. The teacher also directed the learning process of students. In the classroom, the teacher identified the lesson objectives and guided the instruction by explanation of the information. This was generally followed by student practice. Students were passive listeners. Teacher-centered instruction also included lesson plans, teacher lectures and presentations and frequent assessments. In the teacher-centered classroom, teachers were expected to be the subject matter experts. They presented the information in textbooks and when students asked questions, they guided the students to think in such a way that they arrive at 'correct' answers (Carter, 1997)

On the other hand, student centered instruction contained planning, teaching and assessment around the needs and abilities of our students. Learning would be better when topics are relevant to the students' lives, needs, and interests. Furthermore, in this way students would be actively engaged in creating, understanding, and connecting to knowledge (McCombs and Whistler, 1997). In ideal student-centered classroom, the students were not just memorizing information, but they were allowed to work with and use the information alone or with others. The teacher took the control of the classroom and students were allowed to explore, experiment, and discover on their own. By its nature, student centered instruction was adaptable to meet the needs of every student (Stuart 1997). In order to design any lesson, the teacher had to think of the students, rather than the topic or content to be taught.

Davidson (1985) reviewed 79 studies that compared student achievement in small group settings with traditional whole-class instruction. As a result, in only two of the studies control-group students performed better than the small group students.

When using small groups for mathematics instruction, teachers should:

- choose such activities that deal with important mathematical concepts and ideas.
- select the activities that are appropriate for group work.
- consider having students initially work individually and then follow with group work where students share and build on their individual ideas and work.
- give clear instructions and set clear expectations for each group.
- choose interesting activities.
- bring the key concepts to the surface. This can be done either by teacher, by student or both.

Many researches suggested the effectiveness of the whole class discussion. Discussion within the lesson allowed students to see the many ways of both examining the situation and observing the appropriate and acceptable solutions. Wood (1999) established that whole-class discussion works best whenever the discussion expectations were clearly understood. The main difficulty confronted on preparing classroom discussions was that the students set themselves to be active listeners who did not participate in discussions.

Although many experimental studies indicated that student centered instruction had a positive effect on achievement (Davidson (1985), the studies carried out on Turkish students had different results with survey data. Many studies conducted in Turkey (Berberoğlu, 2003; Özdemir, 2003; Yayan, 2003; Kalender, 2004) stated that there was a negative relationship with student-centered activities (or student centered instruction) and achievement. These studies conducted to obtain the factors affecting both mathematics and science achievement of Turkish students.

2.5 Perception of Success and Interest

Singh et al. (2002) examined the effects of motivation, interest and academic engagement on mathematics and science achievement on 8th grade students' achievement in mathematics and science. The researchers studied on 3, 227 data of National Education Longitudinal Study implemented in 1988. They used structural equation models to both estimate and test the hypothesized relationships containing 2 motivation factors, 1 attitude factor, and 1 academic engagement factor on achievement in mathematics and science. The results of the study showed that attitudes, motivation and academic time had a positive effect on achievement. The findings of the study also confirmed that attitudes and interest affected achievement.

Kalender (2004) studied on the factors affecting science achievement. Findings of the study stated that there had been a positive effect of perception of interest and success toward mathematics and science on achievement. In the study, 6th, 7th and 8th grade students were examined and the results also showed that students' having higher perception of interest and success tended to be more successful in science. Moreover, students had their highest perception of interest and success in 6th grade and the interest and success level decreased over 7th and 8th grades gradually.

Berberoğlu et al. (2003) examined 8th grade Turkish students' perception of success according to TIMSS Turkish data. The results of this study showed that the students would be more successful as if they felt successful in mathematics and science.

Köller et al. (2001) argued that the role of interest was particularly relevant in mathematics because it was perceived as a very difficult subject in which motivational factors were very important for enhancing academic achievement.

Papanastasiou (2002) investigated the mathematics achievement of 8^{th} grade students of Cyprus who were participated in the Third International Mathematics and Science Study (TIMSS) in 1994-1995. The researcher used structural equation modeling in the study. There were two exogenous variables which were the educational background of the family and reinforcement; and five endogenous variables, socioeconomic status, students' attitudes towards mathematics, teaching, school climate and beliefs about success in mathematics. The results of this study showed that attitudes and belief had a direct affect on mathematics achievement.

Papanastasiou (2000) analyzed the relationship between mathematics achievement and the students' attitudes towards mathematics. The results of the study showed that the students who did well in mathematics generally had positive attitudes towards mathematics. Moreover, those who had positive attitudes on achievement tended to perform better.

2.6 Summary for Literature Review

Many national and international researches, studies, projects, websites and papers were reviewed and as a result, several important points were investigated.

1. There were very limited studies concerning the geometry achievement of the students.
2. There was a positive relationship between socioeconomic status of the students' family and mathematics achievement of the student. In

most of the research, socioeconomic status was determined by parental education level (Berberoğlu et al., 2003; Cho 2002; Kalender, 2004; Caldas & Bankston III, 1997)

3. In addition to parental education level, facilities at home, number of books at home and number of siblings were the variables to explain socioeconomic status (Berberoğlu et al., 2003; Kalender, 2004; Caldas & Bankston III, 1997)
4. Attitudes toward mathematics had a positive effect on mathematics achievement. Positive beliefs and interests increased the mathematics achievement (Singh et al., 2002; Berberoğlu et al., 2003; Kalender, 2004; Papanastasiou, 2002; Köller et al., 2001).
5. According to studies containing experimental ones mostly, student centered instruction had a positive effect on both mathematics achievement and achievement in general (Wood, 1999; Davidson, 1985).
6. National studies based on survey data (Berberoğlu et al., 2003; Özdemir, 2003; Yayan, 2003; Kalender, 2004) had different results. According to these studies, student-centered activities had a negative effect on both the mathematics and science achievement of the students. Although there was an inconsistent relationship with student-centered instruction and mathematics achievement, the type of the studies (experimental versus survey) should be taken into consideration.
7. Some of the researchers suggested that traditional method was not a good way of teaching. Instead, small group settings or whole class discussions were better to teach a topic. (Davidson, 1985; Wood, 1999)

CHAPTER 3

METHODOLOGY

In the methodology part of this study; population and sample, instruments, validity and reliability studies are presented.

3.1 Population and Sample

Population of the Student Assessment Program-2002 (SAP-2002) study contained the students from state primary schools, primary regional boarding schools and private primary schools in grade levels 4, 5, 6, 7 and 8. As far as the sample was concerned, it consisted of approximately 112,000 students from 573 primary schools in 47 provinces which were distributed through all 7 geographical regions of Turkey. In this study, only the grade levels 6, 7 and 8, constituting 29,952 students, were analyzed. Table 3.1 indicated the distribution of students across grade levels.

Table 3.1 Distribution of the Students across Grade Levels

Grade Level	Frequency	Valid Percentage	Cumulative Percentage
6	10307	34.4 %	34.4 %

(Table 3.1 continued)

7	9985	33.3 %	67.7 %
8	9660	32.3 %	100 %

First of all, types of school covered in the sample were; state primary schools, primary regional boarding schools and private primary schools. In determining the number of schools and students in each province, schools from both city centers and rural areas were selected. Moreover, schooling rate and number of students per school were also taken into consideration. For example, in Blacksea region not only the schools were distributed through wide range of area but also the school populations were too low. Therefore, more schools were included in this region to obtain the representative number of population. Classrooms from the selected schools were also determined by using random sampling. The sampling of 112,000 students was carried out by the MONE. However, for the analysis of this study a smaller sample was randomly selected among 112,000 students. Table 3.2 showed the distribution of the provinces in which SAP-2002 was applied.

Table 3.2 Distribution of 47 Provinces

Marmara	**Ege**	**Akdeniz**	**İç Anadolu**	**Karadeniz**	**Doğu Anadolu**	**G. Doğu Anadolu**
Balıkesir	Afyon	Adana	Ankara	Artvin	Ağrı	Adıyaman
Bursa	Aydın	Antalya	Eskişehir	Bolu	Bingöl	Diyarbakır
Çanakkale	İzmir	Hatay	Kayseri	Çorum	Bitlis	G. Antep
Edirne	Kütahya	Isparta	Konya	Gümüşhane	Elazığ	Ş. Urfa
İstanbul	Manisa	K. Maraş	Nevşehir	Ordu	Erzurum	Şırnak

(Table 3.2 continued)

Sakarya	Muğla	Sivas	Samsun	Hakkari
Tekirdağ			Sinop	Kars
			Trabzon	Malatya
			Zonguldak	Van

The gender distribution of the participants throughout the study was presented below, in Table 3.3.

Table 3.3 Gender Distribution of the Participants in SAP-2002 across the Grade Levels

Gender	**Grade Levels**		
	6	**7**	**8**
Male	5738	5551	5486
Female	4547	4418	4171
TOTAL	10307	9985	9660

3.2 Instruments

In SAP-2002 Study, an achievement test was given to the students. The test contained four parts. They were mathematics, science, social sciences and Turkish. The number of questions for each part differentiated from 20 to 25. In addition to this test, 6^{th}, 7^{th} and 8^{th} grade students were given a questionnaire to collect data about socioeconomic status (SES), classroom activities, outdoor activities, and thoughts about examinations …etc.

3.2.1 Mathematics Achievement Test (MAT)

Achievement test was an assessment that measures the students' acquired knowledge and skills in one or more common content areas. In this study among mathematics, science, social sciences and Turkish branches, data of the mathematics achievement tests were used. It consisted of multiple choice type questions. The response rates of the Mathematics Achievement Test (MAT) were given in Appendix A.

In the analysis of Mathematics Achievement Test, the wrong answers did not cancel out the correct ones. Furthermore, the response rates were very high.

Two types of booklets were used in SAP-2002 Study. The distribution of booklets in different grade levels was given in Table 3.4.

Table 3.4 Distribution of Booklets in Different Grade Levels

Grade Level	Booklet A	Booklet B
6	10519	10307
7	10355	9985
8	9876	9660
TOTAL	**30750**	**29952**

Data of the booklet B were used in this study. In each booklet a few questions were included as anchor items. These anchor items not only made the test more secure but also monitored the progress among grade levels and equated the test forms as well. Most of the questions in each booklet did not resemble each other; but they contained the same subject matter and had the same ability level. Table 3.5 presented the number of items in booklets A and B.

Table 3.5 Number of Items in Booklets A and B

Grade Level	Turkish	Mathematics	Science	Social Sciences
4	11+4*	10+5*	10+5*	13+2*
5	11+4*	10+5*	10+5*	13+2*
6	16+4*	15+5*	15+5*	18+2*
7	16+4*	15+5*	15+5*	18+2*
8	21+4*	20+5*	15+5*	18+2*

* indicated the number of anchor items

The property of anchor items was not used in the present study.

3.2.2 Student Questionnaire

In SAP-2002, students were given a student questionnaire as well as the achievement tests. In this questionnaire, students from all grade levels were asked to fill out 58 items. The reason for collecting such data was to get information about the students' socioeconomic status, classroom activities, outdoor activities, interests, attitudes toward examinations, etc.

Items 1, 2, 3 and 4 were related to the parental education level, number of siblings in the family and number of books at home. All these 4 items had 5 choices.

The next 8 items (5 – 12) were concerned with facilities at home which contains computer, television, washing machine, dishwasher, telephone, own study desk, own study room and internet connection. These contained 2-point scale, “Yes” or “No”.

As far as the next 16 items (13-28) were concerned with how often the students do the outdoor activities such as watching TV, doing sports, reading newspapers/magazines, playing with friends, studying lesson, private tutoring, using computers, etc. These were 5-point Likert type items (never, less than 1 hour, between 1-2 hours, between 3-5 hours, and more than 5 hours).

The following 4 items (29-32) were asked to obtain information about the time spent for Turkish, Social Sciences, Mathematics and Science homework. These items were 5-point Likert type items (never, less than 1 hour, between 1-2 hours, between 3-5 hours, and more than 5 hours).

Items 33-36 were concerned with the interest toward Turkish, social sciences, mathematics and science. They were 4-point items including “None”, “I do not like”, “I like” and “I like very much” choices.

Next 4 items (37-40) were about the perception of success in Turkish, social sciences, mathematics and science. These items gave 4 choices: “very unsuccessful”, “unsuccessful”, “successful” and “very successful”.

The items from 41 to 52 obtained information about the frequency of the classroom activities for Turkish, social sciences, mathematics and science lessons. Lectures given by teacher/student, group work, doing exercises during lesson, distributing exercise sheets, etc. were the items of this part. Four-point items had the following alternatives: “never”, “seldom”, “sometimes” and “frequently”.

Finally, the last 6 items (53-58) were concerned with the attitudes toward examinations. They were 5-point items having the choices, “strongly disagree”, “disagree”, “neutral”, “agree” and “strongly agree”.

The response rates of the student questionnaires, presented in Appendix A, were very high for all grade levels. The smallest response rate of the items in 6th grade student questionnaire was 98.8 %. This value decreased to 98.7 % for the 7th grade student questionnaire. In the 8th grade data set, the items having the least response rates took a value of 98.9 %. As it has been said before, these questionnaire items were developed by the experts in Education Research and Development Directorate (ERDD) of the MONE.

3.3 Validity and Reliability

In Student Assessment Program-2002 (SAP-2002), standardized tests prepared by Education Research and Development Directorate (ERDD) were used. There were four achievement tests, containing Turkish, Mathematics, Science and Social Sciences tests and a student questionnaire in the study. By the help of pilot studies, all the items were technically examined. In the preparation of these tests the following important points were taken into consideration.

1. The content of the tests are appropriate with the curricula.
2. The items are prepared by specialists and teachers according to item-writing rules.
3. In item analysis, the difficulty and discrimination power of each item are measured.
4. Parallel forms are prepared.
5. Directions of the tests, application guides and norm tables are prepared.
6. After pilot study, item and factor analysis are done and the items get standardized (Educational Research and Development Directorate, 2005).

The tests developed by ERDD were implemented under fully standard conditions. Academicians, administrators, experts and teachers participated in this phase so as to get the data in most accurate manner. All of the items in both the achievement test and the student questionnaire had high validity and reliability coefficients.

As an evidence for construct-related validity, factor analysis was conducted. Therefore, the observed variables were grouped in factors. Among all the groups, factors of the interest were determined. In other words, some of the interested factors were selected and given a proper group name. In the model, the selected factors were known as the latent variables. In the second part of the study, the models gained from factor analysis were tested. Taking all the observed variables of selected latent variables made the model worth complex to understand. Indeed, taking the observed variables which had high factor loadings in each latent variable was more preferable in constituting the model. The observed variables contained in latent variables and their factor loadings would be presented in the next chapter.

Regarding the latent variables, the alpha reliability coefficients of the latent independent variables were calculated. The reliability coefficient of the student questionnaire containing 58 items for 6th, 7th and 8th grade students was 0.819. According to Adams and Wu (2002), the reliability value, 0.819, for student questionnaire was high.

3.4 Data Collection

SAP-2002 was applied in April 12, 2002 by the collaboration of Educational Research and Development Directorate (ERDD), General Directorate of Educational Technologies (EGITEK) and General Directorate of Elementary Education. Moreover, ERDD was responsible for the construction and implementation of standardized tests, analysis and evaluation of the results.

In SAP-2002 study, 48 experts of ERDD, 47 deputy directors, 315 county department chiefs, 573 primary education observers, 573 school principals and approximately 6900 teachers took a role. Before SAP-2002 was conducted, seminars had been organized to inform the people participated in the study. During the application, all the measures were taken to obtain the standardized conditions.

ERDD also supported this study by providing the data files in SPSS format (.sav), supplementary reports and manuals.

3.5 Procedure

As a starting point of the study, information about the SAP-2002 was collected from publications, reports, and web sites. Data files were examined in order to understand the content of the study.

Next, another search for Structural Equation Modeling (SEM) was done through the library resources available and via internet. Information about SEM, modification indexes, model fit, modeling procedures, etc. were the searched words at that time. During that time, library materials and internet were examined to gain information about using LISREL package program.

Then, factor analysis of the student questionnaire was taken into consideration. Many attempts were done in order to find the latent structure of the student questionnaire for each grade level. In other words, factor analysis of the student questionnaire was administered for each grade level separately. At the end, a parallel structure of the latent variables was defined across the grade levels.

While analyzing the mathematics achievement test, first of all the items of the achievement test were separated as Mathematics or Geometry for each grade levels. A content based separation was conducted. For 6^{th}, 7^{th}

and 8^{th} grades, Table 3.6 showed whether a question asked for mathematics knowledge of the students or evaluated the students' geometry success.

Table 3.6 Types of the Questions in Mathematics Achievement Tests across Grade Levels

Grade Level	Item #	
	Mathematics	**Geometry**
6	1, 3, 4, 5, 6, 8, 9, 10, 11, 12, 14, 15, 16,17, 18, 19, 20	2, 7, 13
7	1, 2, 3, 4, 5, 7, 8, 10, 11, 12, 14, 15, 16, 17, 19, 20	6, 9, 13, 18
8	2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 24	1, 6, 15, 16, 17, 25

After grouping the questions as Mathematics and Geometry for each 6^{th}, 7^{th} and 8^{th} grades, factor analyses were applied. The questions which had higher factor loadings were selected to represent the latent variables MATH_ACH and GEO_ACH for the structural equation modeling analysis.

3.6 Data Analyses

Data of the SAP-2002 study were obtained in three SPSS files named as 6B.SAV, 7B.SAV and 8B.SAV. Variables in the files were defined in both nominal and scale measures. The properties of each variable in the data sets were well-defined. At first, all the variables were examined. Then, the variables were selected according to the interest of investigation.

3.6.1 Missing Data Analyses

One of the most important factors in defining and grouping the items which would be contained and analyzed in the study was the missing percentages. Each of the items in the achievement test and questionnaire was analyzed in detail.

Considering that 10 % was the general criterion for the missing data, the missing values of all the items were compared with this value. In student questionnaire, there was no item having a missing data percentage greater than 1.3 %. In mathematics achievement test of 6^{th} grades, the missing values were under 10 % and ranged from 0.5 % to 5 %. In 7^{th} grades, the least and the most missing value percentages were 0.5 % and 5.4 %, respectively. The missing values of the 8^{th} grades of the study ranged from 0.5 % to 7.2%.

During the study, in all of the factor analyses conducted, listwise deletion method was used. Possibility of ambiguous or wrong results in the factor analyses, the listwise deletion method was selected in order to handle the missing data. In addition, listwise deletion method was also used in structural equation modeling for getting meaningful results.

3.6.2 Effect Sizes

Effect size was the size of the relationship among variables. In other words, measures of association summarized the size of the effect (in order to assess how important the finding would be if true). Multiple correlation was symbolized as R and squared multiple correlation could be demonstrated as R^2. Classification of effect sizes were grouped according to multiple correlation values (R). Cohen (1988) classified the effect sizes according to R^2 values as 0.01 was small, 0.09 was medium and 0.25 or greater was large. In social studies, the effect size was mostly small to medium (Weinfurt, 1995).

The corresponding R values of these squared multiple correlations could be another classification of the effect sizes. According to this criterion, absolute value of R less than 0.1 was stated as small, around 0.3 was considered as medium and finally values greater than 0.5 behaved as large effect size (Cohen, 1998; as cited by Kline 1998).

3.6.3 Data Analyses

First of all, the data of each grade level was examined to find out whether there was any problem with the variables. Then, Principal Component (PC) analyses with varimax rotation were conducted for each grade level by using SPSS 12.0 for Windows so as to determine the factor structures of each data set of student questionnaire. Indeed, some of the items were eliminated from PC analyses for either the items did not grouped in any of the factors or the item was out of the researcher's interest. After determining the group of factors in each grade, the groups were named according to what was suggested by both the review of literature and previous studies. Principal Component Analysis was applied on mathematics achievement test after grouping the items as Mathematics and Geometry. The selection was done according to the content of the question. When a mathematics achievement test item was about numbers, computation, fractions, problems etc. then it was considered as Mathematics item. On the other hand, when an item asked for the properties of a triangle, rectangle, area or angles then it was set as a Geometry item.

Thereafter, the latent structure of both student questionnaire and mathematics and geometry subtests was obtained by taking the items which have the highest factor loadings. In fact, removing the rest of the items which would not be used for further analysis was feasible at that point. Then, the data file was imported to PRELIS 2.30 which was a part of LISREL 8.54 and the covariance matrix of the data was generated. In

LISREL, models of different grade levels were obtained by using SIMPLIS command language.

The items of the study were not continuous in scale but treated as continuous in statistics. This could cause some problems in the analysis. On the other hand, Maximum Likelihood Estimation method was used in order to estimate parameters and this method was one of the best ways to analyze the data which did not meet the normality and/or interval scale assumption.

3.7 Structural Equation Modeling (SEM)

Structural Equation Modeling (SEM) was the composition of relationship patterns among variables. It included modeling of interactions, nonlinearities, correlated independents, measurement error, correlated error terms, multiple latent independents each measured by multiple indicators, and one or more latent dependents also each with multiple indicators. In the website of Scientific Software International (SSI), the following important sentences about **LI**near **S**tructural **REL**ations were given:

... In the LISREL model, the linear structural relationship and the factor structure are combined into one comprehensive model applicable to observational studies in many fields. The model allows multiple latent constructs indicated by observable explanatory (or exogenous) variables, recursive and nonrecursive relationships between constructs, and multiple latent constructs indicated by observable responses (or endogenous) variables. The connections between the latent constructs compose the structural equation model; the relationships between the latent constructs and their observable indicators or outcomes compose the factor models. All parts of the comprehensive model may be represented in the path diagram and all factor loadings and structural relationships appear as coefficients of the path...(Scientific Software International, History of LISREL, 2005)

The terms in the passage seemed to be difficult to understand. It would be better to give the definitions of the terms and steps of structural equation modeling. Basically, within the Structural Equation Modeling, Path Analysis with Latent Variables was used in the present study.

3.7.1 Definitions of Terms in Structural Equation Modeling

1. Path Diagram

Path diagram was the visualization of the effects, coefficients among the variables. The unidirectional arrows represented the causal relations and the bi-directional curved arrows represented the noncausal or correlational relationships (Kelloway, 1998).

Schumacker and Lomax (1996) defined the other important terms in Structural Equation Modeling as:

2. Observed or Indicator Variables

Observed variables were the characteristics of individuals measured directly by an instrument/item.

3. Latent or Unobserved Variables

Latent variables were variables that were not measured by the instruments directly, however, they were formed by combination of two or more observed variables. Latent variables included both dependent and independent variables.

4. Latent Dependent Variables

Latent dependent variable was the latent variable which was affected by other latent variables in the model. Measurements of these variables were based on the observed dependent variables.

5. Latent Independent Variables

Latent independent variable was the latent variable which was not affected by other latent variables in the model. Measurements of these variables were based on the observed independent variables.

6. Measurement Models

The measurement models were the parts of a SEM model dealing with the latent variables and their indicators. A pure measurement model was a confirmatory factor analysis (CFA) model in which there was an unmeasured covariance between each possible pair of latent variables.

7. Structural Models

Structural models were the set of exogenous and endogenous variables in the model, together with the direct effects connecting them and the disturbance terms for these variables.

8. Direct Effect

Direct effects were the path coefficients in the model.

9. Indirect Effect

Indirect effect could also be called as mediator effect. There were intervening variables in the model to transmit the effects of prior variables to the latent dependent variable.

10. The Measurement Coefficients

- The λ_y (lowercase lambda sub y) and λ_x (lowercase lambda sub x) values indicated the relationships between the latent variables and observed variables. These coefficients were known as factor loadings. These coefficients were used to identify the validity coefficient.

- The ε (lowercase epsilon) and δ (lowercase delta) were the measurement errors for the Ys and Xs, respectively. They were used to obtain the reliability coefficients.

11. The Structure Coefficients

- The β (lowercase beta) values indicated the strength and direction of the relationship among the latent dependent variables.
- The γ (lowercase gamma) values indicated the strength and direction of the relationship among latent dependent variables and latent independent variables.

12. Principal Component (PC) Analysis

Principal Component Analysis was a technique for determining the factors which were independent among each other.

3.7.2 Steps of Structural Equation Modeling

Structural Equation Modeling consisted of five steps.

1. Specify the model

Model specification was the process by which the researcher asserts which effects were null, which were fixed to a constant (usually 1.0), and which varied. The hypotheses stated and the reasons for selecting such latent variables and observed variables in the study were constituted at this step.

2. Identification

Identification of a model dealt with whether unique values could be found for the parameters to be estimated in the theoretical model. According to this, models might be underidentified, identified, or overidentified. In an identified model, the unique set of path coefficient should be provided. The model was said to be underidentified when the number of observations was less than the model parameters. If there were more observations than the model parameters, then this type of model was called overidentified. (Kelloway, 1998).

3. Estimation

Using LISREL package program was a good way of solving sets of structural equations. It also provided estimation of the model parameters. There were a number of estimation techniques and the use of them differentiated according to variable scale and/or distributional property of the variable(s) used in the model. Maximum likelihood, generalized least squares and ordinary least squares and unweighted least squares were some of the examples of estimation techniques. In this study, maximum likelihood estimation was consistent and asymptotically efficient in large samples; therefore maximum likelihood estimation was preferred in the study.

4. Testing the model fit

Basically, there were many fit indices which indicated that the model fitted the data or not. The major of the indices mostly used to test the model are: Chi-Square, Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (S-RMR). The detailed information about the fit indices was given below.

Chi Square (χ^2)

Chi Square measured the significance of the difference between two structural equation models of the same data, in which one model was a nested subset of the other. Mainly, chi-square difference was the standard test statistic for comparing a modified model with the original one. If chi-square difference showed no significant difference between the unconstrained original model and the nested, constrained modified model, then the modification was accepted. For the studies using larger samples, it tended to give significant values.

Goodness of Fit Index (GFI)

GFI was based on the ratio of the sum of the squared differences between the observed and reproduced matrices to the observed variances (Schumacker & Lomax, 1996). Moreover, GFI ranged from 0 to 1. The values exceeding 0.9 indicated a good fit to the data (Kelloway, 1998).

Adjusted Goodness-of-Fit Index (AGFI)

AGFI was a variant of GFI for the degrees of freedom of a model relative to the number of variables (Schumacker & Lomax, 1996). Like GFI, AGFI tended to be larger as sample size increases correspondingly. It had a range of 0 to 1. Having a value 0.9 and above indicated a good fit.

Standardized Root-Mean-Square Residual (S-RMR)

The smaller the standardized RMR, the better the model fit. S-RMR was the average difference between the predicted and observed variances and covariances in the model, based on standardized residuals. S-RMR was ranged from 0 to 1. Values lower than 0.05 were acceptable. If S-RMR was equal to 0 then model fit was perfect.

Root-Mean-Squared Error of Approximation (RMSEA)

RMSEA was also called RMS or RMSE or discrepancy per degree of freedom. By convention, there was good model fit if RMSEA was less than or equal to .05. If the value of RMSEA was very close to 0 (for example 0.01) the type of the fit became perfect. In Table 3.7, fit indices and their criterion values were given.

Table 3.7 Fit Indices Used in the Study

Fit Index	**Criteria**
Chi-Square (χ^2)	Non-significant
Goodness of Fit Index (GFI)	> 0.90
Adjusted Goodness of Fit Index (AGFI)	> 0.90
Root Mean Square Error of Approximation (RMSEA)	< 0.05
Standardized Root Mean Square Residual (S-RMR)	< 0.05

5. Respesify the model

The model's fit indices could give a poor fit. One index or more than one fit indices sometimes did not take the desired values. At this time, LISREL suggested some modification indices and parameter tests. They contained either adding, deleting or maybe modifying the paths or some modifications with error variances, covariances etc. When the model was modified, the model was reassessed on the same data but with the modification. In this study, modification suggestions were considered and applied for all three models of different grade levels.

CHAPTER 4

RESULTS

This chapter mainly contained the presentation of the results of the current study. The results would be presented mainly in two parts: preliminary analysis and inferential analysis. The former contained the factor analyses conducted in order to determine the factors according to the data. On the other hand, the latter i.e. inferential analysis included structural equation modeling. The results of the models for each grade level would be examined in this section.

4.1 Preliminary Analysis

Factor analyses were conducted to map the factor structure of the data set. The mission of them was basically to group the common variables. Furthermore, how these variables were related to the factor groups could also be determined after factor analyses.

In this study, there are 58 items in student questionnaire. In addition, there were mathematics achievement tests for grades 6, 7 and 8. The numbers of questions contained in these tests were 20, 20 and 25, respectively. All of the three grade levels had separate data files.

The principal component analyses were conducted to identify the factor structure of both the student questionnaire and the mathematics achievement tests of each grade. In student questionnaire, some of the items were not included into the analysis. This was because of two reasons. First of all, some of the items did not get a definite factor loading, i.e. the factor loading of this item was distributed among the factors. The second and the last reason, some items were out of the analysis due to the interest of investigation. After these remarkable points, the best factor structure of the selected items was modeled. In student questionnaire 4 factor groups were selected. They were: socioeconomic status (SES), perception of success and interest toward mathematics and science, teacher-centered activities and student-centered activities. For each latent variable, four observed variables having the highest factor loadings were selected.

PC analysis was conducted with the help of SPSS 12.0 for both the student questionnaires and the mathematics achievement tests of all grades, 6^{th}, 7^{th} and 8^{th} separately. The analysis of mathematics achievement test was different from the analysis of student questionnaire. First of all, mathematics achievement tests were grouped into two: Mathematics and Geometry. Then the PC analyses were implemented for each of them. The detailed analysis of both student questionnaire and mathematics achievement test was given as follows.

4.2 Analysis of Student Questionnaires

In this part, student questionnaire given to all grades in the study was analyzed in details. As it was mentioned before, 58 items were placed in the questionnaire. The description of the items was given in Table 4.1.

Table 4.1 Item Description of the Student Questionnaire

Variable Name	Item Description
moth_edu	Mother's education level
fath_edu	Father's education level
num_sibl	Number of siblings
num_book	Number of books at home
computer	Computer at home
tv	Television at home
wash_msh	Washing machine at home
dish_wsh	Dish washer at home
phone	Telephone at home
own_desk	Own study desk at home
own_room	Own study room at home
internet	Internet connection at home
out_tv	Out of school / Watch TV and video
out_sport	Out of school / Do sports
out_newsp	Out of school / Read newspaper, reference, book
out_money	Out of school / Work for money
out_playf	Out of school / Play with friends
out_hw	Out of school / Do homework
out_lessn	Out of school / Study lesson
pt_sci	Out of school / Private tutoring for science
pt_math	Out of school / Private tutoring for mathematics
pt_soc	Out of school / Private tutoring for social sciences
pt_turk	Out of school / Private tutoring for Turkish
out_club	Out of school / Club, society and other social activities
out_resch	Out of school / Study and research in the library
out_hwc	Out of school / Do homework by using computer
out_cgame	Out of school / Play computer games
out_cafe	Out of school / Go to cinema, cafe with friends
hw_turk	Time spent for Turkish homework
hw_soc	Time spent for social sciences homework
hw_math	Time spent for mathematics homework
hw_sci	Time spent for science homework
int_turk	Perception of interest toward Turkish
int_soc	Perception of interest toward social sciences

(Table 4.1 continued)

int_math	Perception of interest toward mathematics
int_sci	Perception of interest toward science
suc_turk	Perception of success toward Turkish
suc_soc	Perception of success toward social sciences
suc_math	Perception of success toward mathematics
suc_sci	Perception of success toward science
tea_less	Classroom activities / Lesson given by teacher
stu_less	Classroom activities / Lesson given by students
stu_disc	Classroom activities / Student discussions
stu_dist	Classroom activities / Discussion between teacher and students
ssheet	Classroom activities / Work on study sheets
tea_samp	Classroom activities / Solve sample exercises
stu_grpw	Classroom activities / Do group work
tea_life	Classroom activities / Teacher gives daily life examples
tech_mat	Classroom activities / Use technological materials in classroom
tea_mat	Classroom activities / Use proper classroom material
tea_exp	Classroom activities / Teacher does experiments
stu_exp	Classroom activities / Students do experiments
exam_afr	Exams / I'm afraid of exams
exam_ref	Exams / Exams don't reflect my own success
exam_not	Exams / School would be better if exams didn't exist
exam_anx	Exams / Anxiety of exam affects my success negatively
exam_imp	Exams / Exam results provide me a chance for improving myself
exam_gra	Exams / Exams shouldn't be used for only grading

4.2.1 Analysis and Results of 6th Grade Student Questionnaire Data

Before analyzing the items, pointing out what the Kaiser-Meyer-Olkin (KMO) and Bartlett’s Tests measures would be informative. KMO was a measure whether the distribution of values was adequate to conduct factor analysis (George and Mallery, 2001). On the other hand, Bartlett's test of sphericity verified whether the correlation matrix was an identity matrix, which would indicate that the factor model was inappropriate (adapted from SPSS Help file). KMO varied from 0 to 1 and KMO overall should be 0.60 or higher to proceed with factor analysis (Tabachnik & Fidell, 2001). Bartlett's test of sphericity should be significant ($p<0.05$) so that the correlation matrix was not an identity matrix. KMO and Bartlett's Tests values of the 6th grade student questionnaire were presented in Table 4.2.

Table 4.2 KMO and Bartlett's Tests of 6th Grade Student Questionnaire

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.865
Bartlett's Test of Sphericity	Approx. Chi-Square	132791.6
	df	1653
	Sig.	0.000

The value of KMO was greater than 0.6 and the Bartlett's Test was significant. Therefore, principal component analysis could be applied to the 6th grade student questionnaire data. After the analysis, 11 of the 58 items were excluded from the PC analyses. The reason for excluding the following 9 items was their ambiguous factor loadings in the Rotated Component Matrix.

- Out of school / Work for money
- Classroom activities / Use technological materials in classroom
- Television at home
- Telephone at home
- Out of school / Go to cinema, cafe with friends
- Out of school / Club, society and other social activities
- Out of school / Read newspaper, reference, book

- Out of school / Study and research in the library
- Classroom activities / Work on study sheets

The remaining 2 items were excluded from the further analysis because they were not related with mathematics. More specifically, the items given below were the list of classroom activities done in science classroom.

- Classroom activities / Teacher does experiments
- Classroom activities / Students do experiments

Finally, the remaining 47 items were analyzed and as a result of the Principal Component Analysis, these items were grouped in 10 factors. Scree Plot was used to identify how many factors would be occurred. The factor loadings of the 6th grade student questionnaire items were given in Table 4.3.

Table 4.3 Principal Component Analysis Results of the Selected Items of 6th Grade Student Questionnaire

Rotated Component Matrix(a)										
	Component									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mother's education level	**0.721**			0.237				0.135		
Father's education level	**0.684**			0.213				0.112		
Own study desk at home	**0.651**						0.156	-0.102		
Number of books at home	**0.636**	0.112		0.240					0.104	
Number of siblings	**-0.622**							-0.113		
Own study room at home	**0.596**						0.182	-0.141		
Washing machine at home	**0.563**									0.113

(Table 4.3 continued)

Dish washer at home	**0.556**			0.373						
Time spent for Turkish homework		**0.777**								
Time spent for mathematics homework		**0.766**							0.227	
Time spent for social sciences homework		**0.748**			0.164					
Time spent for science homework		**0.742**			0.173					
Out of school / Study lesson		**0.568**			0.138				0.124	0.174
Out of school / Do homework	0.137	**0.561**						0.126		0.256
Out of school / Private tutoring for Turkish			**0.845**							
Out of school / Private tutoring for science			**0.837**							
Out of school / Private tutoring for social sciences			**0.831**							
Out of school / Private tutoring for mathematics	0.131		**0.803**							
Computer at home	0.323			**0.747**						
Out of school / Do homework by using computer			0.175	**0.739**						
Internet connection at home	0.225			**0.697**						
Out of school / Play computer games			0.104	**0.693**						0.276
Perception of success for social sciences					**0.655**				0.159	0.132
Perception of interest for science		0.140			**0.654**					
Perception of success for science					**0.654**				0.181	
Perception of interest for social sciences		0.154			**0.642**				-0.106	
Perception of success for Turkish	0.123				**0.480**				0.392	
Perception of interest for Turkish		0.217		-0.100	**0.449**			0.167	0.130	-0.149
Exams / Anxiety of exam affects my success negatively						**0.651**				
Exams / I'm afraid	-0.172					**0.623**				

(Table 4.3 continued)

of exams										
Exams / Exams don't reflect my own success						**0.598**				
Exams / School would be better if exams didn't exist				0.130	-0.138	**0.535**		-0.114	-0.136	
Exams / Exam results provide me a chance for improving myself						**0.534**		0.143	0.115	
Exams / Exams shouldn't be used for only grading	0.133					**0.470**		0.149	0.191	
Classroom activities / Student discussions							**0.658**	0.146		
Classroom activities / Lesson given by students							**0.595**	-0.201		
Classroom activities / Do group work							**0.542**	0.153		
Classroom activities / Discussion between teacher and students							**0.516**	0.378		
Classroom activities / Lesson given by teacher							-0.107	**0.632**		
Classroom activities / Solve sample exercises							0.167	**0.618**	0.107	
Classroom activities / Use proper classroom material	0.214	0.101					0.264	**0.515**		
Classroom activities / Teacher gives daily life examples							0.383	**0.473**		
Perception of success for mathematics					0.183				**0.828**	0.103
Perception of interest for mathematics		0.201			0.162				**0.713**	
Out of school / Play with friends										**0.772**
Out of school / Do sports	0.180	0.114		0.143			0.116			**0.646**
Out of school / Watch TV and video	0.228	0.121					-0.141	0.122		**0.534**

As a result, the output of the principal component analysis was observed and Component 1, Component 7, Component 8 and Component 9 (2 of the items in Component 5 were joined to this factor group) were selected for further analysis. Specifically, these 4 factors were given the following names: socioeconomic status, perception of success and interest toward mathematics and science, teacher-centered activities and student-centered activities. These variables were chosen to constitute the latent variables of the model. In addition, there was a one to one correspondence with the observed variables and the selected items.

Using all the observed variables generated problems in the representation of latent variable. Therefore, each latent variable would be presented by some of the observed variables which have the higher factor loadings. It would be better to take the highest factor loadings but selecting the third or fourth observed variable instead of two would be also acceptable. Eigenvalues, variances and cumulative variance percentages for selected factors were given in Table 4.4.

Table 4.4 Rotation Sums of Squared Loadings for Selected Factors in 6th Grade

	Factor	Eigenvalue	% of Variance	Cumulative % Variance
Mother's education level	Socioeconomic Status (SES)	2.294	14.340	14.340
Father's education level				
Own study desk at home				
Dish washer at home				
Perception of success for mathematics	Perception of Success and Interest toward Mathematics	1.918	11.990	26.330
Perception of interest for mathematics				
Perception of success for science				
Perception of interest for				

(Table 4.4 continued)

science	and Science			
Classroom activities / Lesson given by teacher Classroom activities / Solve sample exercises Classroom activities / Use proper classroom material Classroom activities / Teacher gives daily life examples	Teacher-Centered Activities	1.724	10.778	37.108
Classroom activities / Student discussions Classroom activities / Lesson given by students Classroom activities / Do group work Classroom activities / Discussion between teacher and students	Student-Centered Activities	1.717	10.729	47.836

In the table above, the total variance explained by these 4 factors was 47.836.

4.2.2 Analysis and Results of 7th Grade Student Questionnaire Data

Before the Principal Component Analysis of 7th grade student questionnaire data, Kaiser-Meyer-Olkin (KMO) and Bartlett's Tests should be checked. The results of these tests were shown in Table 4.5.

Table 4.5 KMO and Bartlett's Tests of 7th Grade Student Questionnaire

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.875
Bartlett's Test of Sphericity	Approx. Chi-Square	135805.8
	df	1653
	Sig.	0.000

KMO value was greater than 0.60 which was the lower bound and Bartlett's Test was significant ($p=0.000<0.05$). These results allowed us to continue with the analysis of 7^{th} grade student questionnaire data.

After the analysis was conducted, 11 of the 58 items were excluded and would not be used in modeling. There were two reasons for excluding the items. The first reason was the ambiguous factor loadings of the items in the Rotated Component Matrix. The following 9 items were the examples of this type.

- Out of school / Work for money
- Classroom activities / Work on study sheets
- Classroom activities / Use technological materials in classroom
- Television at home
- Telephone at home
- Out of school / Go to cinema, cafe with friends
- Out of school / Read newspaper, reference, book
- Out of school / Club, society and other social activities
- Out of school / Study and research in the library

Again, the following 2 items were excluded from the further analysis because they were not related to mathematics.

- Classroom activities / Teacher does experiments
- Classroom activities / Students do experiments

Finally, the remaining 47 items were analyzed and as a result of the Principal Component Analysis, these items were grouped in 10 factors. Scree Plot was used here to determine the number of factors. The factor loadings of the 7^{th} grade student questionnaire items were given in Table 4.6.

Table 4.6 Principal Component Analysis Results of the Selected Items of 7th Grade Student Questionnaire

Rotated Component Matrix(a)										
	Component									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mother's education level	**0.676**		0.111	0.297					0.144	
Own study desk at home	**0.659**							0.131		
Father's education level	**0.645**		0.115	0.266					0.134	
Own study room at home	**0.630**							0.176	-0.119	
Number of siblings	**-0.618**								-0.131	-0.102
Number of books at home	**0.592**	0.157	0.129	0.308	0.112				0.125	
Washing machine at home	**0.589**									
Dish washer at home	**0.508**		0.149	0.439						
Time spent for Turkish homework		**0.769**								
Time spent for mathematics homework	0.129	**0.768**			0.254					
Time spent for social sciences homework		**0.755**					0.175			
Time spent for science homework		**0.745**			0.237			0.102		
Out of school / Study lesson	0.112	**0.623**	0.100		0.180		0.118		0.138	
Out of school / Do homework	0.102	**0.619**					0.105		0.148	0.155
Out of school / Private tutoring for Turkish			**0.888**							
Out of school / Private tutoring for social sciences			**0.858**							
Out of school / Private tutoring for science	0.176		**0.852**	0.127						
Out of school / Private tutoring for mathematics	0.188		**0.830**	0.123						
Computer at home	0.289			**0.777**						
Out of school / Do homework by using computer		0.109	0.149	**0.731**						0.141
Internet connection at home	0.221			**0.724**						
Out of school / Play				**0.649**						0.363

(Table 4.6 continued)

computer games										
Perception of success for mathematics		0.125			**0.742**					0.126
Perception of success for science					**0.718**		0.192			
Perception of interest for mathematics		0.189			**0.672**				0.121	
Perception of interest for science		0.160			**0.637**		0.146			-0.106
Exams / Anxiety of exam affects my success negatively						**0.650**				
Exams / Exams don't reflect my own success						**0.613**				
Exams / I'm afraid of exams	-0.152				-0.103	**0.594**				
Exams / Exam results provide me a chance for improving myself					0.142	**0.497**				
Exams / School would be better if exams didn't exist				0.145	-0.182	**0.480**	-0.123			0.107
Exams / Exams shouldn't be used for only grading	0.122				0.139	**0.463**			0.125	
Perception of interest for social sciences		0.125					**0.759**	0.103		
Perception of success for social sciences					0.196		**0.730**			0.118
Perception of success for Turkish		0.152			0.327		**0.513**		0.164	
Perception of interest for Turkish		0.198			0.107		**0.508**		0.180	-0.166
Classroom activities / Student discussions								**0.670**	0.141	
Classroom activities / Do group work								**0.566**		
Classroom activities / Lesson given by students								**0.544**	-0.135	
Classroom activities / Discussion between teacher and students								**0.541**	0.382	
Classroom activities / Lesson given by teacher									**0.650**	
Classroom activities / Solve sample exercises								0.162	**0.617**	
Classroom activities / Use proper classroom material	0.214	0.121						0.268	**0.500**	
Classroom activities /								0.373	**0.446**	

(Table 4.6 continued)

Teacher gives daily life examples										
Out of school / Play with friends										**0.778**
Out of school / Do sports	0.164	0.118		0.128				0.109		**0.697**
Out of school / Watch TV and video	0.261	0.145						-0.178	0.140	**0.500**

Component 1, Component 5, Component 8 and Component 9 were selected for structural equation modeling analysis. These factors represented the latent variables: socioeconomic status, perception of success and interest toward mathematics and science, teacher-centered activities and student-centered activities. These variables would constitute the latent variables of the model. Observed variables, on the other hand, were the selected items of the factor groups. Therefore, each latent variable would be presented by a number of observed variables. In Table 4.7, eigenvalues, variances and cumulative variance percentages of the chosen factors were given.

Table 4.7 Rotation Sums of Squared Loadings for Selected Factors in 7th Grade

	Factor	**Eigenvalue**	**% of Variance**	**Cumulative % Variance**
Mother's education level	Socioeconomic Status (SES)	2.289	14.308	14.308
Father's education level				
Dish washer at home				
Own study desk at home				
Perception of success for science	Perception of Success and Interest toward Mathematics and Science	2.159	13.491	27.799
Perception of success for mathematics				
Perception of interest for science				
Perception of interest for mathematics				

(Table 4.7 continued)

Classroom activities / Lesson given by teacher	Teacher-Centered Activities	1.735	10.841	38.641
Classroom activities / Solve sample exercises				
Classroom activities / Use proper classroom material				
Classroom activities / Teacher gives daily life examples				
Classroom activities / Student discussions	Student-Centered Activities	1.690	10.563	49.204
Classroom activities / Lesson given by students				
Classroom activities / Do group work				
Classroom activities / Discussion between teacher and students				

Total variance explained by these 4 factors was 49.204.

4.2.3 Analysis and Results of 8th Grade Student Questionnaire Data

Kaiser-Meyer-Olkin (KMO) and Bartlett's Tests should be checked before the principal component analysis of 8th grade student questionnaire. The results of these tests were given in Table 4.8.

Table 4.8 KMO and Bartlett's Tests of 8th Grade Student Questionnaire

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.877
Bartlett's Test of Sphericity	Approx. Chi-Square	156862.4
	df	1653
	Sig.	0.000

KMO had a value of 0.877 which was greater than 0.60. Bartlett's Test was significant ($p=0.000<0.05$). These results were enough to continue with the principal component analysis of 8th grade student questionnaire data.

10 of the 58 items were discarded from the analysis because of the ambiguous factor loadings. The following items were the list of excluded items

- Classroom activities / Use technological materials in classroom
- Television at home
- Telephone at home
- Out of school / Work for money
- Classroom activities / Work on study sheets
- Out of school / Go to cinema, cafe with friends
- Out of school / Club, society and other social activities
- Out of school / Study and research in the library

In addition to these, the following 2 items were also excluded from the further analysis because they were not compatible with mathematics.

- Classroom activities / Teacher does experiments
- Classroom activities / Students do experiments

Finally, the remaining 48 items were analyzed and according to the scree plot result, 10 factors were identified in this analysis. The factor loadings of the 8th grade student questionnaire items were given in Table 4.9.

Table 4.9 Principal Component Analysis Results of the Selected Items of 8th Grade Student Questionnaire

Rotated Component Matrix(a)										
	Component									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Time spent for Turkish homework	**0.790**									
Time spent for science homework	**0.763**				0.228					
Time spent for mathematics homework	**0.750**	0.105	0.115		0.298					
Time spent for social sciences homework	**0.739**						0.248			
Out of school / Do homework	**0.631**								0.129	0.132
Out of school / Study lesson	**0.584**	0.196	0.219		0.257		0.115			0.173
Out of school / Read newspaper, reference, book	**0.497**	0.147					0.104		0.117	0.181
Own study desk at home	0.101	**0.683**				0.106				-0.119
Own study room at home		**0.671**				0.139				-0.132
Mother's education level		**0.650**	0.177	0.314						0.170
Father's education level		**0.639**	0.194	0.239						0.132
Number of books at home	0.171	**0.605**	0.182	0.243						0.126
Number of siblings		**-0.601**							-0.119	-0.161
Washing machine at home		**0.582**								
Dish washer at home		**0.516**	0.156	0.391						
Out of school / Private tutoring for Turkish	0.101	0.147	**0.917**	0.100						
Out of school / Private tutoring for social sciences	0.107	0.156	**0.909**	0.102						
Out of school / Private tutoring for science	0.118	0.223	**0.892**	0.129	0.106					
Out of school / Private tutoring for mathematics	0.116	0.226	**0.881**	0.129	0.109					
Computer at home		0.284	0.143	**0.769**						
Out of school / Do homework by using computer				**0.743**					0.125	
Internet connection at home		0.198		**0.741**						
Out of school / Play computer games		0.121		**0.616**					0.367	
Perception of success for	0.113		0.178		**0.748**					

(Table 4.9 continued)

mathematics										
Perception of interest for mathematics	0.202		0.128		**0.708**					0.140
Perception of success for science	0.128				**0.654**		0.260			
Perception of interest for science	0.163				**0.580**	0.109	0.201		-0.119	
Classroom activities / Student discussions						**0.651**				
Classroom activities / Do group work						**0.620**				
Classroom activities / Discussion between teacher and students						**0.569**				0.319
Classroom activities / Lesson given by students						**0.503**				-0.257
Classroom activities / Teacher gives daily life examples						**0.446**				0.364
Perception of interest for social sciences	0.154						**0.754**			
Perception of success for social sciences	0.107				0.192		**0.753**		0.108	
Perception of success for Turkish	0.170	0.111	0.108		0.263		**0.513**			0.231
Perception of interest for Turkish	0.230						**0.482**		-0.237	0.215
Exams / Anxiety of exam affects my success negatively								**0.654**		
Exams / I'm afraid of exams		-0.106			-0.116			**0.624**		
Exams / Exams don't reflect my own success								**0.612**		
Exams / School would be better if exams didn't exist		0.139			-0.203		-0.118	**0.480**	0.109	
Exams / Exam results provide me a chance for improving myself					0.175			**0.451**		0.121
Exams / Exams shouldn't be used for only grading					0.121		0.124	**0.439**		0.220
Out of school / Play with friends									**0.769**	
Out of school / Do sports		0.124							**0.739**	
Out of school / Watch TV and video	0.128	0.269			-0.111	-0.196			**0.436**	0.215
Classroom activities / Lesson given by teacher										**0.580**
Classroom activities / Solve sample exercises	0.107					0.244				**0.551**

(Table 4.9 continued)

Classroom activities / Use proper classroom material	0.128	0.352	**0.459**

The results of the 8th grade student questionnaire data grouped the selected items under 10 factors. In order to obtain similar models, 4 factors were selected: Component 2 as socioeconomic status, Component 5 as perception of success and interest toward mathematics and science, Component 6 as student-centered activities and Component 10 as teacher-centered activities. In the previous analyses of 6th and 7th grade "Classroom activities / Teacher gives daily life examples" were belonging to teacher centered activities. In 8th grade analysis, this item was placed in the group of student-centered classroom activities group. Considering the previous grade analysis and the literature, this item was taken into the teacher-centered classroom activities variable. The eigenvalues, variances and cumulative variance percentages of the chosen factors were shown in Table 4.10.

Table 4.10 Rotation Sums of Squared Loadings for Selected Factors in 8th Grade

	Factor	**Eigenvalue**	**% of Variance**	**Cumulative % Variance**
Mother's education level	Socioeconomic Status (SES)	2.310	14.437	14.783
Father's education level				
Own study desk at home				
Dish washer at home				
Perception of success for science	Perception of Success and	2.102	13.137	27.574
Perception of success for mathematics				

(Table 4.10 continued)

Perception of interest for science	Interest toward Mathematics and Science			
Perception of interest for mathematics				
Classroom activities / Student discussions	Student-Centered Activities	1.729	10.807	38.381
Classroom activities / Lesson given by students				
Classroom activities / Do group work				
Classroom activities / Discussion between teacher and students				
Classroom activities / Lesson given by teacher	Teacher-Centered Activities	1.664	10.398	48.779
Classroom activities / Solve sample exercises				
Classroom activities / Use proper classroom material				
Classroom activities / Teacher gives daily life examples				

Total variance explained by these 4 latent variables was 48.779. In the analysis of student questionnaire for all grade levels, the items were collected as almost same factors. Perception of Success and Interest toward Mathematics and Science, Student-Centered Activities and Teacher-Centered Activities latent variables were determined by the same four observed variables in each grade level. However, the highest four factor loadings in Socioeconomic Status latent variable were different among grade levels. At this point or view, same items having the highest factor loadings for all grade levels were taken to the model.

4.3 Principal Component Analysis of Mathematics Achievement Tests

6^{th} grade Mathematics Achievement Test contained 17 mathematics and 3 geometry items. The distribution of the 20 MAT items of 7^{th} grade was; 16 mathematics questions and 4 geometry questions. When the 8^{th} grade MAT questions were examined, 19 out of 25 items were related to the mathematics concept and the remaining 6 items were geometry. Before Principal Component Analyses of MATs were conducted, Kaiser-Meyer-Olkin (KMO) and Bartlett's Tests of Sphericity should be checked for both Mathematics and Geometry items separately in each grade. Table 4.11 gave the KMO and Bartlett's tests values.

Table 4.11 Results of KMO and Bartlett's Test for Mathematics Achievement Tests on Grade Levels

Test		**Grade Levels**		
		6th Grade	**7th Grade**	**8th Grade**
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.870	0.872	0.940
Bartlett's Test of Sphericity	Approx. Chi-Square	14778.034	13253.734	28041.657
	df	190	190	300
	Sig.	0.000	0.000	0.000

All of the KMO values of the mathematics achievement test were above 0.60 and Bartlett's Test of Sphericity was significant. This permitted the researcher to continue with the principal component analysis of mathematics achievement tests in different grades.

Rotated component matrices were determined so as to define the variables to be used in structural equation modeling stage. In order to handle the missing values in the data, listwise deletion method was used. In the analysis, Varimax rotation was used over the axes to group the factors better. In the mathematics achievement tests, six PC analyses were conducted (for each grade level, two principal component analyses were conducted: one for mathematics subtest and the other for geometry subtest). Indeed, the principal component analyses of mathematics achievement tests did not create two dimensional factor groups (mathematics and geometry). Therefore, the researcher did a content-based separation analysis to create homogeneous subtests (mathematics subtest and geometry subtest).

4.3.1 Analysis of 6th Grade Mathematics Achievement Test

First of all, MAT items of 6th grade were grouped as mathematics and geometry questions. In order to do this, the content of the items were taken into consideration. As a result of the detailed analysis of the items; 2, 7 and 13 were related with geometrical concepts where 1, 3, 4, 5, 6, 8, 9, 10. 11, 12, 14, 15, 16, 17, 18, 19 and 20 asked for mathematics. The factor loadings of the principal component analysis for the geometry items were given in Table 4.12.

Table 4.12 Principal Component Analysis Results of the 6th Grade Geometry Items

	Component
	1
nm13	**0.617**
nm2	**0.576**
nm7	**0.464**

The items 2, 7 and 13 would represent the GEO_ACH in structural equation modeling. On the other hand, principal component analysis of the remaining items i.e. mathematics items, were conducted properly. The factor loadings of the mathematics items were presented in Table 4.13.

Table 4.13 Principal Component Analysis Results of the 6th Grade Mathematics Items

	Component	
	1	**2**
nm11	**0.697**	
nm19	**0.631**	
nm8	**0.614**	
nm18	**0.583**	
nm14	**0.452**	0.239
nm3	**0.388**	0.308
nm1	**0.349**	0.253
nm10	**0.295**	0.270
nm16	**0.283**	0.266
nm6		**0.560**
nm4	0.123	**0.553**
nm5	0.184	**0.468**
nm17		**0.453**
nm15	0.407	**0.451**
nm9		**0.376**
nm20		**0.298**
nm12	0.184	**0.190**

From the table, the items having the highest 4 factor loadings, i.e. nm8, nm11, nm18 and nm19, would represent MATH_ACH in structural equation modeling.

4.3.2 Analysis of 7th Grade Mathematics Achievement Test

The content of the items in 7th grade mathematics achievement test was considered and the items 6, 9, 13, 18 were taken as geometry. On the other hand, the rest of the 16 items containing 1, 2, 3, 4, 5, 7, 8, 10. 11, 12, 14, 15, 16, 17, 19 and 20 were mathematics based items. First of all, the geometry items were analyzed. In Table 4.14, principal component analysis of the 7th grade geometry items were given.

Table 4.14 Principal Component Analysis Results of the 7th Grade Geometry Items

	Component
	1
nm9	**0.617**
nm13	**0.582**
nm6	**0.510**
nm18	**0.498**

Only one component was established. 3 of the 4 geometry items which had the highest factor loadings were selected for the structural equation modeling analysis. The items which would be used for further analysis as GEO_ACH were nm9, nm13 and nm6. By using similar procedure, principal component analysis for mathematics items was conducted and the results were stated in Table 4.15.

Table 4.15 Principal Component Analysis Results of the 7th Grade Mathematics Items

	Component	
	1	**2**
nm4	**0.683**	
nm14	**0.611**	
nm5	**0.569**	
nm19	**0.542**	0.242
nm2	**0.493**	0.221
nm8	**0.362**	0.359
nm16	**0.304**	0.169
nm3	**0.299**	0.289
nm7	**0.284**	0.241
nm1	**0.234**	0.218
nm20		**0.590**
nm11	-0.133	**0.588**
nm15	0.189	**0.446**
nm10	0.259	**0.375**
nm12	0.278	**0.300**
nm17		**0.254**

Items 4, 14 and 20 had the highest factor loadings. Hence, nm4, nm14 and nm20 were the items to form MATH_ACH for 7th grades for further analysis of structural equation modeling.

4.3.3 Analysis of 8th Grade Mathematics Achievement Test

Mathematics achievement test of the 8th grades covered 25 mathematics and geometry questions. Conceptually, the items 1, 6, 15, 16, 17 and 25 were identified as measuring the geometry skills. Moreover, the remaining 19 items were recognized as mathematics. These questions can be listed as follows: 2, 3, 4, 5, 7, 8, 9, 10. 11, 12, 13, 14, 18, 19, 20. 21, 22, 23 and 24. Since the items in both groups were too many to be observed variable, factor analyses were conducted for both mathematics and geometry items. The result of the factor loadings of the geometry items were given in Table 4.16.

Table 4.16 Principal Component Analysis Results of the 8th Grade Geometry Items

	Component
	1
nm17	**0.657**
nm16	**0.604**
nm6	**0.580**
nm15	**0.538**
nm1	**0.503**
nm25	**0.387**

The highest factor loadings of the geometry items were nm17, nm16 and nm6. These variables were grouped under the name GEO_ACH in structural equation modeling. Likewise, factor analysis of mathematics items was done. The output of the factor loadings of these items was presented in Table 4.17.

Table 4.17 Principal Component Analysis Results of the 8th Grade Mathematics Items

	Component		
	1	**2**	**3**
nm20	**0.627**	0.146	
nm8	**0.587**		0.170
nm22	**0.563**		
nm23	**0.558**	0.320	0.143
nm21	**0.515**	0.392	
nm19	**0.361**		0.168
nm24	**0.327**	0.283	
nm9	-0.127	**0.652**	0.135
nm12	0.103	**0.572**	
nm18	0.192	**0.531**	
nm11	0.276	**0.500**	
nm10	0.145	**0.400**	0.197
nm7	0.160	**0.262**	0.224
nm2		0.100	**0.634**
nm3	0.144		**0.625**
nm13		0.234	**0.481**
nm4	0.299		**0.457**
nm5	0.352	0.102	**0.409**
nm14	0.194	0.203	**0.278**

19 items in the analysis were grouped under 3 components. Items having the highest factor loadings were taken as the items of MATH_ACH

variable. In this analysis, the variables nm9, nm2 and nm20 were selected to be the variables in structural equation modeling.

Total variances explained in mathematics achievement tests were given in Table 4.18. According to the table, for the 6th grades, the total variances explained by the mathematics and geometry groups were 25.759 and 35.959 respectively. As far as the 7th grades were considered, total variance explained by the mathematics and geometry groups were 24.992 and 30.686 respectively. Being the last, the total variance of the 8th grades explained by mathematics and geometry were given as 31.765 and 30.416 respectively.

Table 4.18 Summary for Principal Component Analysis of Mathematics Achievement Tests

		Eigenvalue	**% of Variance**	**Cumulative % Variance**
Grade Level	**Tests' Subgroup**			
6	Mathematics	2.501	14.714	14.714
		1.878	11.045	25.759
	Geometry	1.079	35.959	35.959
7	Mathematics	2.354	14.710	14.710
		1.645	10.282	24.992
	Geometry	1.227	30.686	30.686
8	Mathematics	2.330	12.264	12.264
		2.000	10.528	22.792
		1.705	8.973	31.765
	Geometry	1.825	30.416	30.416

4.4 A Summary of Factor Analyses

The Principal Component analysis was conducted and as a result four latent variables were selected for path analysis with latent variable. These variables, Socioeconomic Status (SES), Perception of Success and Interest towards Mathematics and Science (INT_SUC), Teacher-centered Classroom Activities (TEA_CENT) and Student-centered Classroom Activities (STU_CENT) were the same across grade levels.

According to factor analyses of student questionnaires and mathematics achievement tests, some of the observed variables were eliminated and three or four of them were taken to further analysis. This was because of two reasons. First, taking all the items to the model gave a miss fit. Second, latent variables should be in one dimension. According to O'Brien (1994) at least three observed variables should be loaded on each latent variable. Table 4.19, Table 4.20 and Table 4.21 demonstrated the latent and observed variables of the 6th, 7th and 8th grade student questionnaires, respectively.

Table 4.19 Latent and Observed Variables of 6th Grade Student Questionnaire

Latent Variable	**Variable Name**	**Observed Variable**	**Variable Name**
Socioeconomic Status (SES)	SES	Mother's education level	moth_edu
		Father's education level	fath_edu
		Dish washer at home	dish_wsh
		Own study desk at home	own_desk
Perception of Success and Interest	INT_SUC	Perception of success for mathematics	suc_math

(Table 4.19 continued)

toward Mathematics and Science		Perception of interest for mathematics	int_math
		Perception of success for science	suc_sci
		Perception of interest for science	int_sci
Student-Centered Activities	STU_CENT	Classroom activities / Student discussions	stu_disc
		Classroom activities / Lesson given by students	stu_less
		Classroom activities / Do group work	stu_grpw
		Classroom activities / Discussion between teacher and students	stu_dist
Teacher-Centered Activities	TEA_CENT	Classroom activities / Lesson given by teacher	tea_less
		Classroom activities / Solve sample exercises	tea_samp
		Classroom activities / Use proper classroom material	tea_mat
		Classroom activities / Teacher gives daily life examples	tea_life

Table 4.20 Latent and Observed Variables of 7th Grade Student Questionnaire

Latent Variable	**Variable Name**	**Observed Variable**	**Variable Name**
Socioeconomic Status (SES)	SES	Mother's education level	moth_edu
		Father's education level	fath_edu
		Dish washer at home	dish_wsh
		Own study desk at home	own_desk
Perception of Success and Interest toward Mathematics and Science	INT_SUC	Perception of success for mathematics	suc_math
		Perception of interest for mathematics	int_math
		Perception of success for science	suc_sci

(Table 4.20 continued)

		Perception of interest for science	int_sci
Student-Centered Activities	STU_CENT	Classroom activities / Student discussions	stu_disc
		Classroom activities / Lesson given by students	stu_less
		Classroom activities / Do group work	stu_grpw
		Classroom activities / Discussion between teacher and students	stu_dist
Teacher-Centered Activities	TEA_CENT	Classroom activities / Lesson given by teacher	tea_less
		Classroom activities / Solve sample exercises	tea_samp
		Classroom activities / Use proper classroom material	tea_mat
		Classroom activities / Teacher gives daily life examples	tea_life

Table 4.21 Latent and Observed Variables of 8th Grade Student Questionnaire

Latent Variable	**Variable Name**	**Observed Variable**	**Variable Name**
Socioeconomic Status (SES)	SES	Mother's education level	moth_edu
		Father's education level	fath_edu
		Own study desk at home	own_desk
		Dish washer at home	dish_wsh
Perception of Success and Interest toward Mathematics and Science	INT_SUC	Perception of success for mathematics	suc_math
		Perception of interest for mathematics	int_math
		Perception of success for science	suc_sci
		Perception of interest for science	int_sci
Student-Centered Activities	STU_CENT	Classroom activities / Student discussions	stu_disc
		Classroom activities / Lesson given by students	stu_less

(Table 4.21 continued)

		Classroom activities / Do group work	stu_grpw
		Classroom activities / Discussion between teacher and students	stu_dist
Teacher-Centered Activities	TEA_CENT	Classroom activities / Lesson given by teacher	tea_less
		Classroom activities / Solve sample exercises	tea_samp
		Classroom activities / Use proper classroom material	tea_mat
		Classroom activities / Teacher gives daily life examples	tea_life

For the achievement test, the purpose of the PC analysis was to define uni-dimensional mathematics and geometry subdimensions. The PC analyses of the mathematics achievement tests did not perform two dimensional mathematics tests as desired by the researcher. Thus, for each item groups (mathematics and geometry), the researcher preferred to run separate analysis to create the most homogeneous subtests. As a summary, the latent and observed variables of the 6^{th}, 7^{th} and 8^{th} grade mathematics achievement tests were given in Table 4.22, Table 4.23 and Table 4.24, respectively.

Table 4.22 Variables of 6^{th} Grade Mathematics Achievement Test

Latent Variable	**Variable Name**	**Item Description**	**Variable Name**
Mathematics	MATH_ACH	Basic definition of numbers	NM8
		Use of division in integers	NM11

(Table 4.22 continued)

		Fractions	NM18
		Basic definition of set	NM19
Geometry	GEO_ACH	Calculating areas of triangle and rectangle	NM2
		Intersection of a line and a triangle	NM7
		Basic terms of rectangle	NM13

Table 4.23 Variables of 7th Grade Mathematics Achievement Test

Latent Variable	Variable Name	Item Description	Variable Name
Mathematics	MATH_ACH	Ratio and proportion	NM4
		Fractions	NM14
		Facts about number inequality	NM20
Geometry	GEO_ACH	Calculating areas of triangle and rectangle	NM6
		Basic terms of rectangle	NM9
		Calculation of angle in parallel lines	NM13

Table 4.24 Variables of 8th Grade Mathematics Achievement Test

Latent Variable	Variable Name	Item Description	Variable Name
Mathematics	MATH_ACH	Consecutive numbers	NM2
		Natural numbers	NM9
		Fractions	NM20
Geometry	GEO_ACH	Calculation of the angle in triangle and parallelogram	NM6
		Corresponding angle	NM16
		Similarity of triangles	NM17

4.5 Structural Equation Modeling

In this part of the study, 6^{th}, 7^{th} and 8^{th} grade students' mathematics and geometry achievement models would be presented. LISREL package program was used in testing the models. SIMPLIS as providing command language and PRELIS as getting the covariance matrix were the major supporters of this program. In LISREL, listwise deletion method was used. Significance levels were taken as 0.05 during the study.

4.5.1 Mathematics and Geometry Achievement Model for the 6^{th} Grade Level

At first, proposed model of the 6^{th} grade was tested under the latent and observed variables gained in the analysis. Then as a result of the modification index, seven covariance terms were added to SIMPLIS syntax to attain to the model having the highest modification indices. The final SIMPLIS syntax of the 6^{th} grades was presented in Appendix B. In addition, standardized solution coefficients of the LISREL's basic structural model were presented in Figure 4.1. Another LISREL output, Figure 4.2 gave t-value coefficients of the same structural model of 6^{th} grade. Moreover, LISREL estimates of parameters in measurement model containing both the standardized values and the t-values can be found in Appendix C.

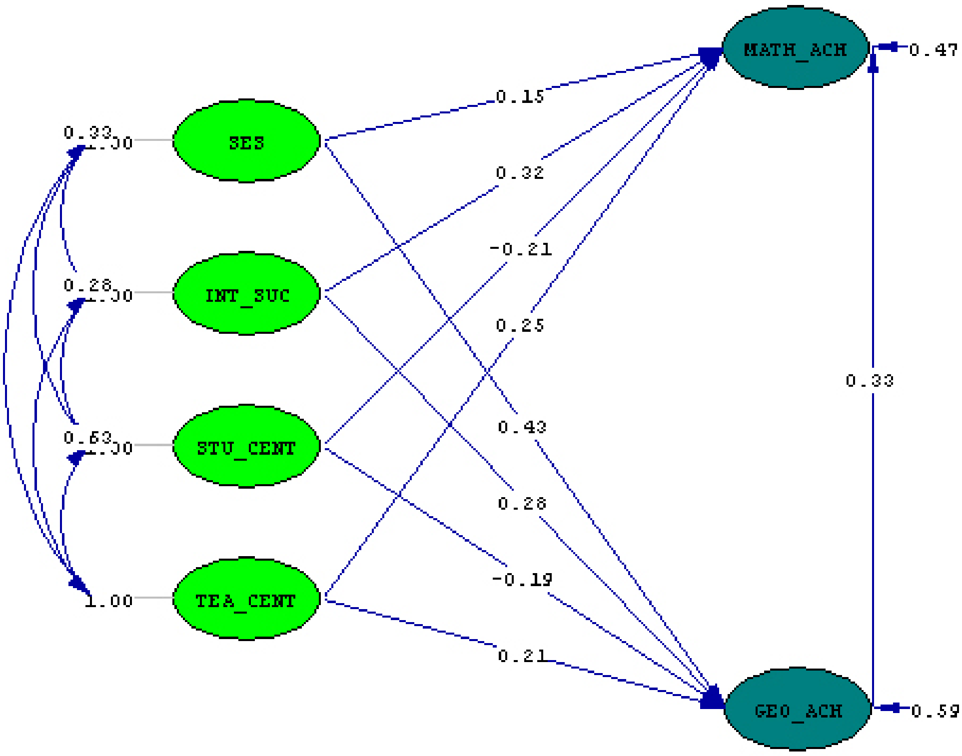

Figure 4.1 LISREL Estimates of Parameters in Structural Model for the 6th Graders (Coefficients in Standardized Value)

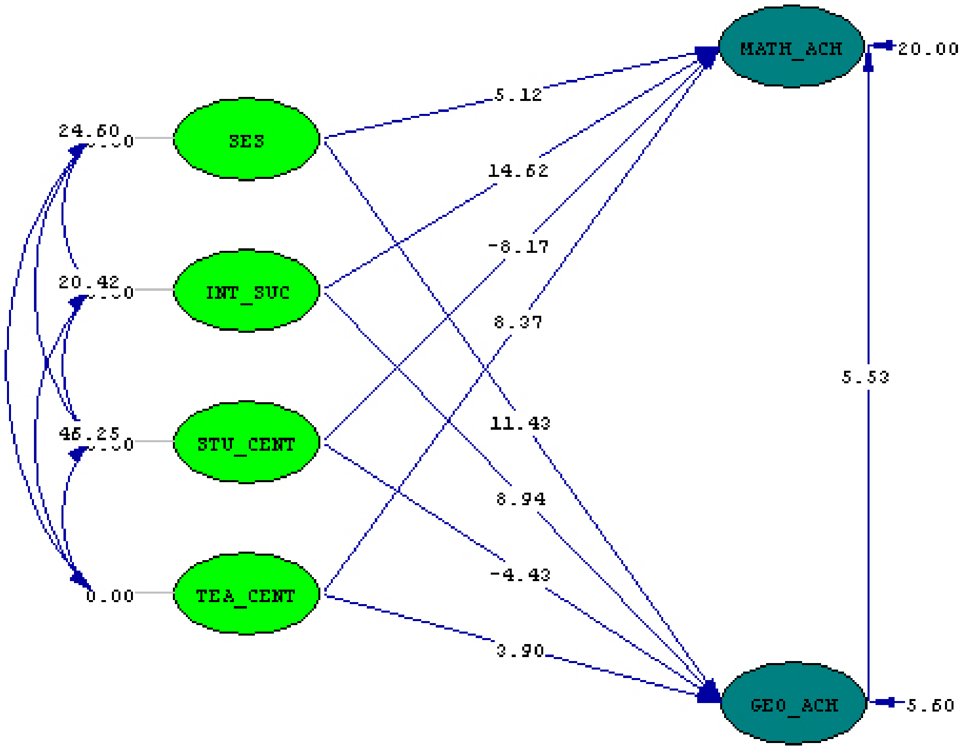

Figure 4.2 LISREL Estimates of Parameters in Structural Model for the 6th Graders (Coefficients in t-Values)

The structural equation model had six latent variables which were Socioeconomic Status (SES), Perception of Interest and Success towards Mathematics and Science (INT_SUC), Student Centered Activities (STU_CENT), Teacher Centered Activities (TEA_CENT), Mathematics Achievement (MATH_ACH) and Geometry Achievement (GEO_ACH). First four of them affected the last two. In other words, Mathematics Achievement (MATH_ACH) and Geometry Achievement (GEO_ACH) were stated as latent dependent variables. On the other hand, Socioeconomic Status (SES), Perception of Success and Interest towards Mathematics and

Science (INT_SUC), Student Centered Activities (STU_CENT) and Teacher Centered Activities (TEA_CENT) were defined as latent independent variables. The fit indices for the 6th grade model were given in Table 4.25.

Table 4.25 Fit Indices of the Model Tested for 6th Grade

Fit Index	**Criteria**	**Value**
Chi-Square	Non-significant	1941.99 (P = 0.0)
Goodness of Fit Index (GFI)	> 0.90	0.98
Adjusted Goodness of Fit Index (AGFI)	> 0.90	0.98
Root Mean Square Error of Approximation (RMSEA)	< 0.05	0.029
Standardized Root Mean Square Residual (S-RMR)	< 0.05	0.032

All the fit indices except Chi-Square (χ^2) indicated fit between the model and data. The χ^2 criterion was known to have a tendency to indicate a significant probability level when the sample size increased, generally above 200 (Schumacker & Lomax, 1996). The sample size for the 6th grade was 10116. The large sample size made this test statistic significant. The results of the 6th grade study showed that the standardized λ_x and λ_y coefficients for observed variables were given in Table 4.26.

Table 4.26 λ_x and λ_y Path Coefficients of the 6th Grade Study

Latent Variable	**Observed Variable**	**λ_x and λ_y coefficients**
SES	MOTH_EDU	0.56 (λ_x)

(Table 4.26 continued)

	FATH_EDU	0.45 (λ_x)
	DISH_WSH	0.77 (λ_x)
	OWN_DESK	0.68 (λ_x)
INT_SUC	INT_MATH	0.93 (λ_x)
	INT_SCI	0.27 (λ_x)
	SUC_MATH	0.75 (λ_x)
	SUC_SCI	0.39 (λ_x)
STU_CENT	STU_DISC	0.36 (λ_x)
	STU_LESS	0.13 (λ_x)
	STU_GRPW	0.50 (λ_x)
	STU_DIST	0.54 (λ_x)
TEA_CENT	TEA_LESS	0.25 (λ_x)
	TEA_SAMP	0.42 (λ_x)
	TEA_MAT	0.46 (λ_x)
	TEA_LIFE	0.38 (λ_x)
MATH_ACH	NM8	0.63 (λ_y)
	NM11	0.72 (λ_y)
	NM18	0.59 (λ_y)
	NM19	0.65 (λ_y)
GEO_ACH	NM2	0.23 (λ_y)
	NM7	0.26 (λ_y)
	NM13	0.29 (λ_y)

Structure coefficient values, γ (lowercase gamma) and β (lowercase beta) indicated the direction and the strength of the relationships not only between the latent dependent and latent independent variables but also among the latent dependent variables, respectively. These values were displayed in Table 4.27 and 4.28.

Table 4.27 Structure Coefficients (γ) of Mathematics Achievement Model of the 6th Grades

Latent Independent Variables	γ	Latent Dependent Variables
SES	0.15	MATH_ACH
INT_SUC	0.32	
STU_CENT	-0.21	
TEA_CENT	0.25	
SES	0.43	GEO_ACH
INT_SUC	0.28	
STU_CENT	-0.19	
TEA_CENT	0.21	

Table 4.28 Structure Coefficient (β) of Mathematics Achievement Model of the 6th Grades

Latent Dependent Variable	β	Latent Dependent Variable
GEO_ACH	0.33	MATH_ACH

In LISREL, the squared multiple correlation (R^2) was found for each variable. R^2 has a meaning of the proportion of the explained variance. As an example, an R^2 value of 0.40 meant that 60% of the variance of a variable was explained by another variable. Cohen's (1988) classification of the effect sizes measured (R^2) was given as follows: up to 0.01 was stated as small, around 0.09 was behaved as medium and 0.25 or up had a large effect size. R^2 values for observed variables were given in Table 4.29.

Table 4.29 R^2 Values for the Observed Variables of 6th Grades

Observed Variable	**R^2**	**Observed Variable**	**R^2**
MOTH_EDU	0.54	TEA_LESS	0.10
FATH_EDU	0.48	TEA_SAMP	0.26
DISH_WSH	0.59	TEA_MAT	0.37
OWN_DESK	0.46	TEA_LIFE	0.33
INT_MATH	0.51	NM8	0.40
INT_SCI	0.04	NM11	0.52
SUC_MATH	0.72	NM18	0.35
SUC_SCI	0.18	NM19	0.42
STU_DISC	0.33	NM2	0.05
STU_LESS	0.07	NM7	0.07
STU_GRPW	0.38	NM13	0.08
STU_DIST	0.49		

In Table 4.30, R^2 values of the latent variables MATH_ACH and GEO_ACH were given.

Table 4.30 R^2 Values for the Latent Variables of 6th Grade

Latent Variables	**R^2**
MATH_ACH	0.47
GEO_ACH	0.41

The R^2 values given in the table above indicated that 47% of the mathematics achievement (MATH_ACH) was explained by the four latent dependent variables (SES, INT_SUC, TEA_CENT and STU_CENT) and GEO_ACH. Moreover, 41% of geometry achievement (GEO_ACH) was explained by four latent dependent variables (SES, INT_SUC, TEA_CENT and STU_CENT).

In the study, LISREL generated the direct and indirect effects constituting the total effect. The path coefficients in Table 4.27 were given in terms of direct effects. Here, direct effects were found by subtracting indirect effects from the total effects. In the following tables, Table 4.31 and 4.32, the indirect and the total effects for endogenous and exogenous latent variables were given.

Table 4.31 Indirect Effects of Exogenous Latent Variable on Endogenous Latent Variables in Grade 6

	SES	**INT_SUC**	**STU_CENT**	**TEA_CENT**
MATH_ACH	0.14	0.09	-0.06	0.07
GEO_ACH	-	-	-	-

Table 4.32 Total Effects of Exogenous Latent Variable on Endogenous Latent Variables in Grade 6

	SES	**INT_SUC**	**STU_CENT**	**TEA_CENT**
MATH_ACH	0.29	0.41	-0.27	0.32
GEO_ACH	0.43	0.28	-0.19	0.21

Finally, Reduced Form Equations of the 6th grades were;

MATH_ACH = 0.29*SES + 0.41*INT_SUC - 0.27*STU_CENT + 0.32*TEA_CENT

For mathematics achievement equation of 6th grade, Errorvar.= 0.53, $R^2 = 0.47$. In the equation above mathematics achievement was given in terms of latent independent variables.

GEO_ACH = 0.43*SES + 0.28*INT_SUC - 0.19*STU_CENT + 0.21*TEA_CENT

Errorvar.= 0.59, $R^2 = 0.41$ for the equation of geometry achievement of 6th grade in terms of the latent independent variables.

4.5.2 Mathematics and Geometry Achievement Model for the 7th Grade Level

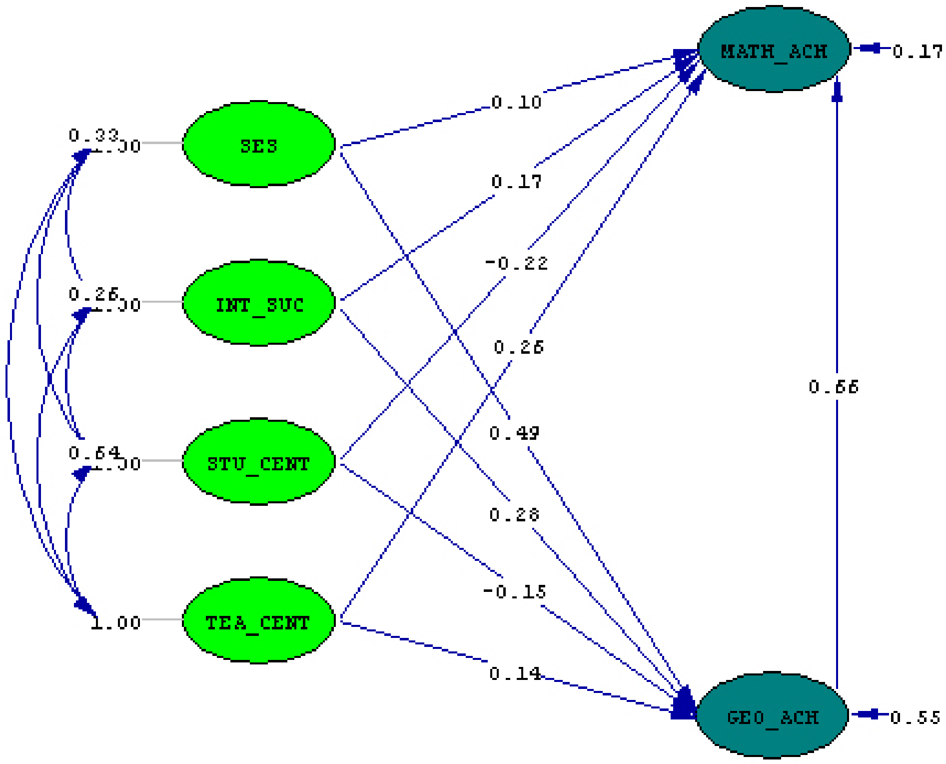

Figure 4.3 LISREL Estimates of Parameters in Structural Model for the 7th Graders (Coefficients in Standardized Value)

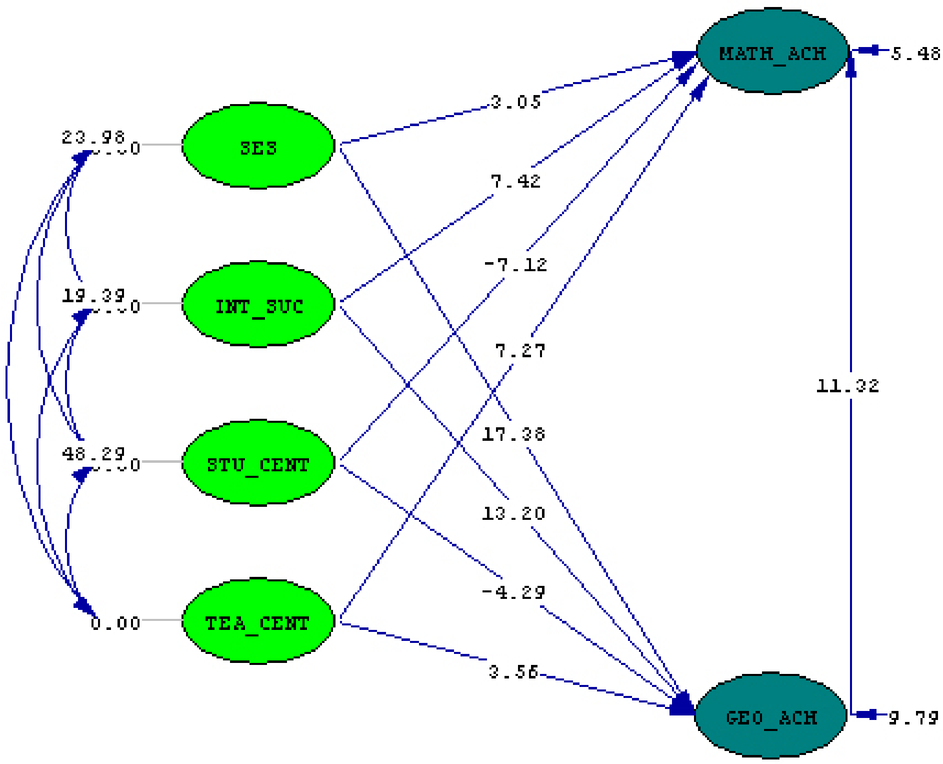

Figure 4.4 LISREL Estimates of Parameters in Structural Model for the 7th Graders (Coefficients in t-Values)

In 7th grade's structural equation model, there were six latent variables listed as follows: Socioeconomic Status (SES), Perception of Success and Interest towards Mathematics and Science (INT_SUC), Student Centered Activities (STU_CENT), Teacher Centered Activities (TEA_CENT), Mathematics Achievement (MATH_ACH) and Geometry Achievement (GEO_ACH). Mathematics Achievement (MATH_ACH) and Geometry Achievement (GEO_ACH) were stated as latent dependent variables. However, Socioeconomic Status (SES), Perception of Success and Interest towards Mathematics and Science (INT_SUC), Student Centered Activities (STU_CENT) and Teacher Centered Activities

(TEA_CENT) were set as latent independent variables. 7th grade model had the fit indices which were shown in Table 4.33.

Table 4.33 Fit Indices of the Model Tested for 7th Grade

Fit Index	**Criteria**	**Value**
Chi-Square	Non-significant	2081.56 (P = 0.0)
Goodness of Fit Index (GFI)	> 0.90	0.98
Adjusted Goodness of Fit Index (AGFI)	> 0.90	0.97
Root Mean Square Error of Approximation (RMSEA)	< 0.05	0.032
Standardized Root Mean Square Residual (S-RMR)	< 0.05	0.030

All the fit indices except Chi-Square (χ^2) indicated fit between the model and data. The χ^2 criterion was known to have a tendency to indicate a significant probability level when the sample size increased, generally above 200 (Schumacker & Lomax, 1996). The sample size for the 7th grade was 9566. This huge sample size made this test statistically significant. According to the analysis, the standardized λ_x and λ_y coefficients for observed variables were given in Table 4.34.

Table 4.34 λ_x and λ_y Path Coefficients of the 7th Grade Study

Latent Variable	**Observed Variable**	**λ_x and λ_y coefficients**
SES	MOTH_EDU	0.53 (λ_x)

(Table 4.34 continued)

	FATH_EDU	0.42 (λ_x)
	DISH_WSH	0.80 (λ_x)
	OWN_DESK	0.65 (λ_x)
INT_SUC	INT_MATH	0.90 (λ_x)
	INT_SCI	0.40 (λ_x)
	SUC_MATH	0.71 (λ_x)
	SUC_SCI	0.42 (λ_x)
STU_CENT	STU_DISC	0.33 (λ_x)
	STU_LESS	0.14 (λ_x)
	STU_GRPW	0.39 (λ_x)
	STU_DIST	0.52 (λ_x)
TEA_CENT	TEA_LESS	0.28 (λ_x)
	TEA_SAMP	0.45 (λ_x)
	TEA_MAT	0.49 (λ_x)
	TEA_LIFE	0.36 (λ_x)
MATH_ACH	NM4	0.60 (λ_y)
	NM14	0.58 (λ_y)
	NM20	0.35 (λ_y)
GEO_ACH	NM6	0.33 (λ_y)
	NM9	0.40 (λ_y)
	NM13	0.40 (λ_y)

Structure coefficient values, γ (lowercase gamma) and β (lowercase beta) indicated the direction and the strength of the relationships not only between the latent dependent and latent independent variables but also among the latent dependent variables, respectively. These values would be given in Table 4.35 and Table 4.36.

Table 4.35 Structure Coefficients (γ) of Mathematics Achievement Model of the 7th Grades

Latent Independent Variables	γ	Latent Dependent Variables
SES	0.10	MATH_ACH
INT_SUC	0.17	
STU_CENT	-0.22	
TEA_CENT	0.26	
SES	0.49	GEO_ACH
INT_SUC	0.28	
STU_CENT	-0.15	
TEA_CENT	0.14	

Table 4.36 Structure Coefficient (β) of Mathematics Achievement Model of the 7th Grades

Latent Dependent Variable	β	Latent Dependent Variable
GEO_ACH	0.66	MATH_ACH

As it was explained before, R^2 described the proportion of the explained variance. R^2 values for observed variables of 7th grades were given in Table 4.37.

Table 4.37 R^2 Values for the Observed Variables of 7th Grades

Observed Variable	R^2	Observed Variable	R^2
MOTH_EDU	0.55	TEA_LESS	0.11

(Table 4.37 continued)

FATH_EDU	0.48	TEA_SAMP	0.27
DISH_WSH	0.64	TEA_MAT	0.36
OWN_DESK	0.42	TEA_LIFE	0.30
INT_MATH	0.46	NM4	0.36
INT_SCI	0.09	NM14	0.34
SUC_MATH	0.87	NM20	0.12
SUC_SCI	0.26	NM6	0.11
STU_DISC	0.33	NM9	0.16
STU_LESS	0.09	NM13	0.16
STU_GRPW	0.24		
STU_DIST	0.52		

In Table 4.38, R^2 of the latent variables MATH_ACH and GEO_ACH was given.

Table 4.38 R^2 Values for the Latent Variables of 7th Grade

Latent Variables	R^2
MATH_ACH	0.59
GEO_ACH	0.45

These R^2 values indicated that 59% of the mathematics achievement (MATH_ACH) was explained by latent variables: SES, INT_SUC, TEA_CENT, STU_CENT and GEO_ACH. In addition, 45% of the geometry achievement (GEO_ACH) was explained by the latent dependent variables of the model (SES, INT_SUC, TEA_CENT and STU_CENT).

In the study, LISREL generated the direct and indirect effects constituting the total effect. The path coefficients in Table 4.35 were given in terms of direct effects. Here, direct effects were found by subtracting indirect effects from the total effects. In the following tables, Table 4.39 and 4.40 the indirect and the total effects for endogenous and exogenous latent variables were given.

Table 4.39 Indirect Effects of Exogenous Latent Variable on Endogenous Latent Variables in Grade 7

	SES	INT_SUC	STU_CENT	TEA_CENT
MATH_ACH	0.32	0.19	-0.10	0.10
GEO_ACH	-	-	-	-

Table 4.40 Total Effects of Exogenous Latent Variable on Endogenous Latent Variables in Grade 7

	SES	INT_SUC	STU_CENT	TEA_CENT
MATH_ACH	0.42	0.35	-0.32	0.36
GEO_ACH	0.49	0.28	-0.15	0.14

Finally, Reduced Form Equations of the 7th grades were;

MATH_ACH = 0.42*SES + 0.35*INT_SUC - 0.32*STU_CENT + 0.36*TEA_CENT

For mathematics achievement equation of 7^{th} grade, Errorvar.= 0.41, R^2 = 0.59. In the equation above mathematics achievement was given in terms of latent independent variables.

GEO_ACH = 0.49*SES + 0.28*INT_SUC - 0.15*STU_CENT + 0.14*TEA_CENT

Errorvar.= 0.55, R^2 = 0.45 for the equation of geometry achievement of 7^{th} grade in terms of the latent independent variables.

4.5.3 Mathematics and Geometry Achievement Model for the 8th Grade Level

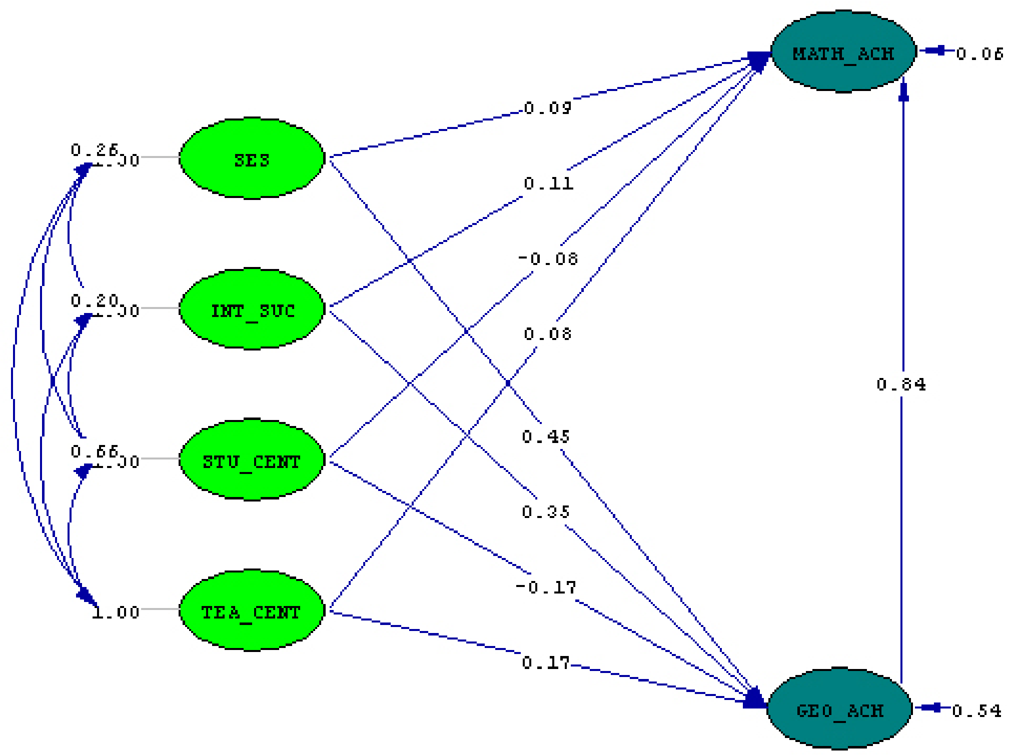

Figure 4.5 LISREL Estimates of Parameters in Structural Model for the 8th Graders (Coefficients in Standardized Value)

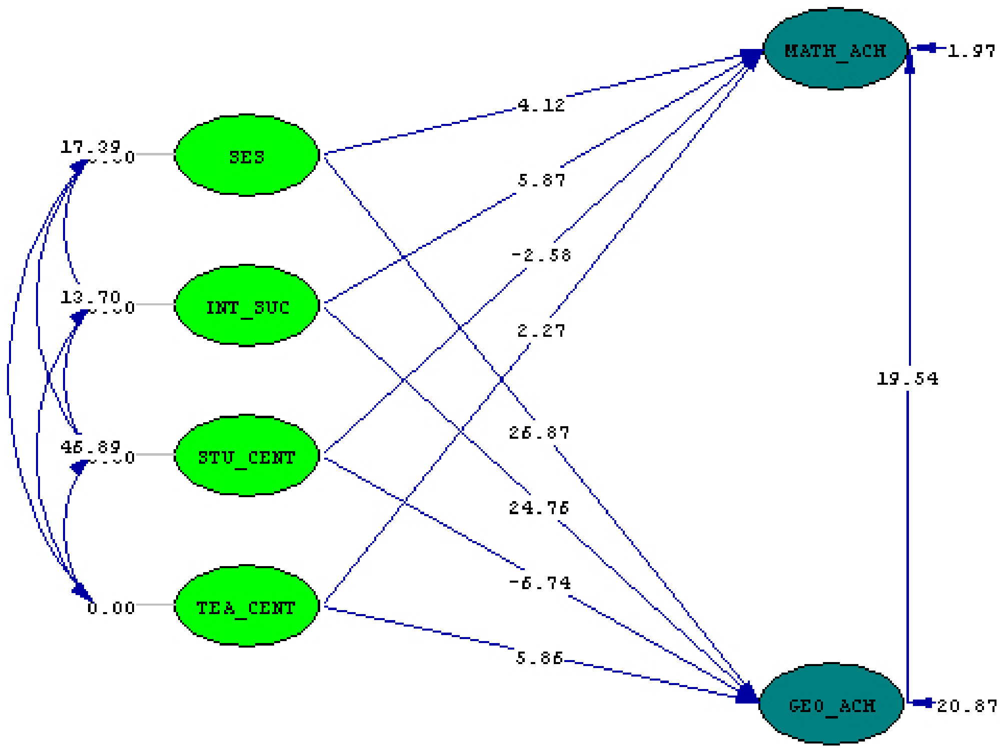

Figure 4.6 LISREL Estimates of Parameters in Structural Model for the 8th Graders (Coefficients in t-Values)

8th grade structural equation model contained six latent variables listed as: Socioeconomic Status (SES), Perception of Success and Interest towards Mathematics and Science (INT_SUC), Student Centered Activities (STU_CENT), Teacher Centered Activities (TEA_CENT), Mathematics Achievement (MATH_ACH) and Geometry Achievement (GEO_ACH). Mathematics Achievement (MATH_ACH) and Geometry Achievement (GEO_ACH) were stated as latent dependent variables. Nevertheless, Socioeconomic Status (SES), Perception of Success and Interest towards Mathematics and Science (INT_SUC), Student Centered Activities (STU_CENT) and Teacher Centered Activities (TEA_CENT) were set as latent independent variables. 8th grade model had the following fit indices which were shown in Table 4.41.

Table 4.41 Fit Indices of the Model Tested for 8th Grade

Fit Index	**Criteria**	**Value**
Chi-Square	Non-significant	2648.12 (P = 0.0)
Goodness of Fit Index (GFI)	> 0.90	0.97
Adjusted Goodness of Fit Index (AGFI)	> 0.90	0.97
Root Mean Square Error of Approximation (RMSEA)	< 0.05	0.037
Standardized Root Mean Square Residual (S-RMR)	< 0.05	0.037

All the fit indices except Chi-Square (χ^2) indicated fit between the model and data. The χ^2 criterion was 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 the 8th grade was 9356. This large sample size made this test statistically significant. According to the analysis, the standardized λ_x and λ_y coefficients for observed variables were given in Table 4.42.

Table 4.42 λ_x and λ_y Path Coefficients of the 8th Grade Study

Latent Variable	**Observed Variable**	**λ_x and λ_y coefficients**
SES	MOTH_EDU	0.52 (λ_x)

(Table 4.42 continued)

	FATH_EDU	0.40 (λ_x)
	OWN_DESK	0.65 (λ_x)
	DISH_WSH	0.83 (λ_x)
INT_SUC	INT_MATH	0.99 (λ_x)
	INT_SCI	0.31 (λ_x)
	SUC_MATH	0.70 (λ_x)
	SUC_SCI	0.36 (λ_x)
STU_CENT	STU_DISC	0.31 (λ_x)
	STU_LESS	0.13 (λ_x)
	STU_GRPW	0.44 (λ_x)
	STU_DIST	0.49 (λ_x)
TEA_CENT	TEA_LESS	0.19 (λ_x)
	TEA_SAMP	0.42 (λ_x)
	TEA_MAT	0.41 (λ_x)
	TEA_LIFE	0.33 (λ_x)
MATH_ACH	NM2	0.32 (λ_y)
	NM9	0.36 (λ_y)
	NM20	0.61 (λ_y)
GEO_ACH	NM6	0.55 (λ_y)
	NM16	0.58 (λ_y)
	NM17	0.67 (λ_y)

Structure coefficient values, γ (lowercase gamma) and β (lowercase beta) indicated the direction and the strength of the relationships not only between the latent dependent and latent independent variables but also among the latent dependent variables, respectively. These values were displayed in Table 4.43 and Table 4.44.

Table 4.43 Structure Coefficients (γ) of Mathematics Achievement Model of the 8th Grades

Latent Independent Variables	γ	Latent Dependent Variables
SES	0.09	MATH_ACH
INT_SUC	0.11	
STU_CENT	-0.08	
TEA_CENT	0.08	
SES	0.45	GEO_ACH
INT_SUC	0.35	
STU_CENT	-0.17	
TEA_CENT	0.17	

Table 4.44 Structure Coefficient (β) of Mathematics Achievement Model of the 8th Grades

Latent Dependent Variable	β	Latent Dependent Variable
GEO_ACH	0.84	MATH_ACH

R^2 described the proportion of the explained variance. R^2 values for observed variables of 8th grades were given in Table 4.45.

Table 4.45 R^2 Values for the Observed Variables of 8th Grades

Observed Variable	R^2	Observed Variable	R^2
MOTH_EDU	0.57	TEA_LESS	0.07

(Table 4.45 continued)

FATH_EDU	0.49	TEA_SAMP	0.25
OWN_DESK	0.43	TEA_MAT	0.31
DISH_WSH	0.69	TEA_LIFE	0.28
INT_MATH	0.56	NM2	0.11
INT_SCI	0.05	NM9	0.13
SUC_MATH	0.87	NM20	0.37
SUC_SCI	0.19	NM6	0.30
STU_DISC	0.32	NM16	0.33
STU_LESS	0.08	NM17	0.44
STU_GRPW	0.32		
STU_DIST	0.50		

In Table 4.46, R^2 of the latent variables MATH_ACH and GEO_ACH was given.

Table 4.46 R^2 Values for the Latent Variables of 8th Grade

Latent Variables	**R^2**
MATH_ACH	0.56
GEO_ACH	0.46

R^2 values of MATH_ACH and GEO_ACH indicated that 56% of the mathematics achievement (MATH_ACH) was explained by latent variables: SES, INT_SUC, TEA_CENT, STU_CENT and also GEO_ACH. In addition, 46% of the geometry achievement (GEO_ACH) was determined by the latent dependent variables of the model (SES, INT_SUC, TEA_CENT and STU_CENT).

In the study, LISREL generated the direct and indirect effects constituting the total effect. The path coefficients in Table 4.43 were given in terms of direct effects. Here, direct effects were found by subtracting indirect effects from the total effects. In the following tables, Table 4.47 and Table 4.48, the indirect and the total effects for endogenous and exogenous latent variables were given.

Table 4.47 Indirect Effects of Exogenous Latent Variable on Endogenous Latent Variables in Grade 8

	SES	**INT_SUC**	**STU_CENT**	**TEA_CENT**
MATH_ACH	0.38	0.30	-0.14	0.14
GEO_ACH	-	-	-	-

Table 4.48 Total Effects of Exogenous Latent Variable on Endogenous Latent Variables in Grade 8

	SES	**INT_SUC**	**STU_CENT**	**TEA_CENT**
MATH_ACH	0.47	0.40	-0.22	0.22
GEO_ACH	0.45	0.35	-0.17	0.17

Finally, Reduced Form Equations of the 8th grades were;

MATH_ACH = 0.47*SES + 0.40*INT_SUC - 0.22*STU_CENT + 0.22*TEA_CENT

For mathematics achievement equation of 8th grades, Errorvar.= 0.44, R^2 = 0.56. In the equation above mathematics achievement was given in terms of latent independent variables.

GEO_ACH = 0.45*SES + 0.35*INT_SUC - 0.17*STU_CENT + 0.17*TEA_CENT

Errorvar.= 0.54, R^2 = 0.46 for the equation of geometry achievement of 8th grades in terms of the latent independent variables.

4.6 Summary of Structural Equation Modeling

After testing the models for each grade level, presenting the important findings and values in one table allowed us to compare the results. Although discussion, results and conclusions of the study would be given in the next chapter, a summary of the standardized path coefficients, direct and total effects was informative. In Table 4.49, direct and total effects between the latent dependent and independent variables for each grade levels were given.

Table 4.49 Standardized Path Coefficients of 6th, 7th and 8th Grade Levels

		Effect Type	Grade Type		
			6th Grade	**7th Grade**	**8th Grade**
SES	**on MATH_ACH**	direct	0.15	0.10	0.09
		total	0.29	0.42	0.47
INT_SUC		direct	0.32	0.17	0.11
		total	0.41	0.35	0.40
TEA_CENT		direct	0.25	0.26	0.08
		total	0.32	0.36	0.22
STU_CENT		direct	-0.21	-0.22	-0.08
		total	-0.27	-0.32	-0.22
SES	**on GEO_ACH**	direct	0.43	0.49	0.45
INT_SUC		direct	0.28	0.28	0.35
TEA_CENT		direct	0.21	0.14	0.17
STU_CENT		direct	-0.19	-0.15	-0.17

Path coefficients from SES to MATH_ACH indicated a small to a medium positive effect for 6th grade. This value gets smaller for the higher grades but still had positive and showed a small effect for 7th and 8th grade. On the other hand, SES had a medium to large effect on GEO_ACH for all grade levels.

INT_SUC had positive effects on MATH_ACH with medium to large effect in grade 6 and small to medium effects in grades 7 and 8. The positive effect of INT_SUC decreased for higher grade levels. Moreover, medium effect of INT_SUC on GEO_ACH was another finding of the present study.

Although TEA_CENT had small to medium positive effect on both MATH_ACH and GEO_ACH, STU_CENT had negative effects on these latent variables with small to medium effect sizes.

CHAPTER 5

DISCUSSION, CONCLUSION AND IMPLICATIONS

In this study, the factors affecting 6^{th}, 7^{th} and 8^{th} grade students' mathematics achievement were both analyzed and interpreted according to SAP-2002 data. After factor analysis, structural equation modeling technique was applied by LISREL package program. After a general model was proposed, it was tested for three grade levels (6^{th}, 7^{th} and 8^{th}). This chapter includes not only the discussion and the conclusion of the results but also the interpretation of the findings presented in this study.

5.1 Discussion of the Results

With this point of view, the factor analyses of all grade levels were presented and interpreted. Thereafter, the results of the models proposed would be indicated.

5.1.1 Factor Analysis of Student Questionnaires

Factor analyses were conducted for the proposed model of each grade level by using principal component analysis with varimax rotation and as a result, 10 components were gained for all grade levels. According to the researcher's interest, four of the factors were selected and then grouped accordingly.

Parental education level, own study desk and dish washer at home had high and positive factor loadings and grouped in a single factor. There was a positive relationship between parental education level and income of the family. Moreover, having a study desk and a dish washer at home were the important terms related to higher socio-economic status. Therefore, these items were grouped as socioeconomic status.

Items related to perception of success and interest in mathematics and science were collected under the heading of a single factor and all the items had positive factor loadings.

Student discussions, lesson given by students, doing group work and discussion between teacher and students were given under a single factor. The name "student centered activities" was set to this item group. Moreover, *lesson given by teacher, teacher solves sample exercises, uses proper classroom materials and gives daily life examples* were grouped and the factor was named as "teacher centered activities".

The variances explained with these factor groups among 6^{th}, 7^{th} and 8^{th} grades were 47.836 %, 49.204 % and 48.779 %, respectively.

5.1.2 Mathematics and Geometry Achievement across Grade Levels

The items of mathematics achievement test were grouped into two parts: mathematics and geometry. The reason for making this grouping was a need to analyze both mathematics and geometry achievements. The items asking for mathematical skills and computation were set as "mathematics" and the items related to angle, area, triangle, rectangle…etc concepts were named as "geometry". After factor analysis, items having the highest factor loadings were taken as the representative item of each factor group.

In the present study, the effects of four latent independent variables (SES, INT_SUC, STU_CENT and TEA_CENT) on two latent dependent variables (MATH_ACH and GEO_ACH) were investigated across grade levels. All the latent variables were included in the model and tested for all grade levels.

In the previous studies, factors related to socioeconomic status were investigated and according to the literature socioeconomic status was an important factor defining the student's success (Coleman, 1966; Berberoğlu et al., 2003; Schiller et al., 2002; Kalender, 2004; Özdemir, 2003; Yayan, 2003; Yang, 2003; Baker and Stevenson, 1986). The effect of socioeconomic status on mathematics and geometry achievement were investigated in the present study and found that socioeconomic status had a positive effect on mathematics achievement for all grade levels. This result made the following interpretation that the students from the families having higher socioeconomic status tended to be more successful than the lower. There was a positive large effect of socioeconomic status over the geometry achievement as well. Results about this factor were consistent with the previous studies. As far as the effect size of socioeconomic status on geometry achievement was concerned, values of 0.43 for 6th grade; 0.49 for 7th grade; and 0.45 for 8th grade were found. These effect sizes were considered as large.

Another important point to be stated about socioeconomic status was that the direct effect of socioeconomic status over the grades decreased. In other words, the effect size had its largest value in 6th grade and lowest value in 8th grade level. It could be said that the impact of home-family background characteristics, which was another way of defining parental education level and facilities at home, were more important at earlier grade (age) levels.

According to the literature, perception of interest, motivation, attitudes and positive beliefs had a relationship with both mathematics achievement and achievement in general (Singh et al., 2002; Kalender, 2004; Berberoğlu et al., 2003; Köller et al., 2001; Papanastasiou, 2002). According to the results of this study, perception of success and interest towards mathematics and science had positive medium effects on mathematics achievement for smaller grades and continued to decrease gradually. On the other hand, perception of success and interest affected the success of geometry positively in the study. The effects of this latent independent variable on geometry achievement were stable on positive medium effect across grade levels. In the literature, attitudes toward mathematics had a positive effect on mathematics achievement. Hence, similar results were obtained with this factor.

Previous experimental studies resulted in the superiority of student-centered instruction as compared to teacher-centered instruction (Davidson, 1985). On the other hand, many survey studies administered in Turkey (Berberoğlu et al. 2003; Kalender, 2004; Özdemir, 2003) found a positive relationship of teacher-centered activities and a negative relationship of student-centered activities with mathematics and/or science achievement. According to the results of this study, for all grade levels teacher-centered activities had a high positive relationship with mathematics achievement in 6^{th} and 7^{th} grade levels. The effect of this latent variable was definitely low on 8^{th} grade level. In geometry, in enhancing the achievement of the students, teacher centered activities played an important role. Teacher centered activities affected the success of students on geometry positively. Teachers getting involved in students' progress lead to more success in mathematics and geometry. In fact, as teacher solves sample exercises, uses proper classroom materials and gives daily life exercises, the students became more successful in mathematics and geometry. Student-centered activities, on the other hand, had a negative effect on mathematics and geometry achievement of the students in all grade levels. These two findings were supported by the literature. However, there were some contradicting results as well. In the literature, the controlled experimental studies indicated the success of student centered instructions over the traditional ones. However, this study was based on analyzing a survey data. The results indicated that, the attempts to apply student-centered activities in the mathematics and geometry classrooms in Turkey were not successful in increasing student achievement. This finding had a very important policy implication. If student-centered activities would be used as a part of the mathematics classes, teachers should be prepared and educated to conduct effective classroom activities in the schools. The result of this survey analysis and others like TIMSS, clearly pointed out a serious problem in implementing student-centered activities in the mathematics and geometry classes in Turkey.

As it was mentioned previously, the β (lowercase beta) values indicated the strength and direction of the relationship among the latent dependent variables. For each of the models in 6^{th}, 7^{th} and 8^{th} grade level, lowercase beta existed between geometry achievement (GEO_ACH) latent variable and mathematics achievement (MATH_ACH) latent variable. These values were 0.33, 0.66 and 0.84 for 6^{th}, 7^{th} and 8^{th} grade levels, respectively. Another finding of the present study indicated that, there was a positive relationship between GEO_ACH and MATH_ACH. The direction of this relationship was from GEO_ACH to MATH_ACH. The strength of the relationship was increasing gradually across the grade levels. This result pointed out that higher achievement in geometry leads higher achievement in mathematics. For higher grade levels, the students being successful in geometry tended to be more successful in mathematics compared to earlier grade levels.

5.2 Conclusions

In this section, the conclusions of the study would be presented. The study based on the SAP-2002 data set and aimed to investigate the factors affecting mathematics achievement of the students. Structural Equation Modeling technique was used to determine the effects of the factors.

The conclusions of the present study wee summarized below:

1. Socioeconomic status significantly and positively influenced mathematics and geometry achievement in all grade levels. This meant that students from the families having higher socioeconomic status were likely to be more successful than the others. Indeed, students having high parental education levels and home facilities (e.g. dish washer, having a study desk etc.) tended to be more successful in mathematics and geometry. The positive effect of socioeconomic status on geometry was much more than the effect on mathematics achievement.

2. An indirect effect of socioeconomic status on mathematics achievement over geometry achievement existed in the models as well. This indirect effect was positive in all of the grade levels and indicated that the students having higher socioeconomic status tended to perform better on geometry achievement and correspondingly on mathematics achievement.

3. For all grade levels, perception of success and interest towards mathematics and science significantly and positively affected both mathematics and geometry achievements. Hence, perception of success and interest were related to the achievement of mathematics and geometry.

4. There was an indirect effect of perception of success and interest towards mathematics and science on mathematics achievement over geometry achievement. This indirect influence was positive in 6^{th}, 7^{th} and 8^{th} grade levels.

5. There was a significant but negative influence of student centered activities on not only mathematics but also geometry achievement of 6^{th}, 7^{th} and 8^{th} grade students. Most probably, the lack of teacher qualifications leaded such a result in this study.

6. Teacher centered activities significantly and positively affected both mathematics and geometry achievement in all grade levels. This result implied that an interactive teacher model was successful in enhancing student learning achievement.

7. There was a significant and positive indirect effect of teacher centered activities on mathematics achievement over geometry achievement.

8. In the 6^{th} grade model, the latent independent variable having the strongest positive and significant effect on mathematics achievement was the perception of success and interest toward mathematics and science. On the other hand, socioeconomic status had the highest positive effect on geometry achievement. The unique latent independent variable having negative effect on both mathematics and geometry achievement was the student centered activities.

9. As far as the 7^{th} grade model is considered, teacher centered activities had the strongest positive effect on mathematics achievement and socioeconomic status had the strongest effect on geometry achievement. Similar in the 6^{th} grade model, only the student centered activities had a negative but significant effect on both mathematics and geometry achievement.

10. Perception of success and interest toward mathematics and science had the strongest positive effect on mathematics achievement in the 8^{th} grade level.

11. The positive effect of students' geometry achievement on their mathematics achievement increased as grade level increased. In other words, the effect of student's geometry achievement on mathematics achievement in 6^{th} grade level was less than the effect in 8^{th} grade level.

5.3 Implications

After this study, the following implications could be suggested:

1. One of the major findings of this study was the effect of teacher centered activities on students' mathematics and geometry achievement. The student centered activities, on the other hand, affected achievement in a negative way. According to this result, teachers should work hard to overcome the difficulties of the students and they should stimulate the thinking abilities of the students through the use of student centered activities. Furthermore, teacher training policies and in-service training should be planned to overcome the difficulty of effective teaching through the use of various teaching methodologies in the classroom.
2. The teachers should not only take care of achievement but also be careful about the effective characteristics of students' in mathematics.
3. The families should improve the students' geometrical perspective by using daily life instruments. There was a positive effect of geometry achievement on mathematics.
4. The effect of perception of success and interest toward mathematics decreased over the higher grades. It was teachers' responsibility to keep and improve the higher grade students' interest in mathematics.

5.4 Recommendations for Further Researchers

Researcher of this study gave the following suggestions:

1. The researcher could carry out further research on modeling the factors affecting mathematics achievement including the use of other variables such as computers and technology usages, private tutoring etc.

2. The researcher could consider gender as another variable in modeling mathematics and geometry achievement.

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APPENDIX A

Response Rates of Mathematics Achievement Tests and Student Questionnaires

Table A.1 Response Rates of Mathematics Achievement Test

Item #	Response Rate		
	Grade 6	Grade 7	Grade 8
1	98.9%	98.7%	99.5%
2	99.1%	98.8%	97.6%
3	99.0%	96.7%	97.1%
4	97.4%	98.5%	98.1%
5	97.7%	97.0%	98.2%
6	97.9%	99.2%	97.1%
7	97.4%	99.1%	96.0%
8	99.5%	98.6%	98.0%
9	97.0%	99.1%	98.8%
10	98.1%	96.6%	95.2%
11	99.2%	98.7%	92.8%
12	97.1%	98.0%	98.2%
13	98.4%	95.9%	97.3%
14	97.5%	99.5%	98.0%
15	98.5%	94.6%	98.6%
16	97.9%	98.0%	94.8%
17	96.0%	96.0%	97.1%
18	99.2%	97.1%	94.7%
19	98.0%	98.7%	96.2%
20	95.0%	95.0%	98.7%
21			94.3%
22			96.7%
23			96.9%
24			94.0%
25			94.2%

Table A.2 Response Rates of the 6th Grade Student Questionnaire

Item #	Response Rate	Item #	Response Rate
1	99.5	**30**	100
2	99.2	**31**	100
3	99.1	**32**	100
4	99.2	**33**	100
5	99.0	**34**	100
6	99.3	**35**	100
7	99.3	**36**	100
8	99.1	**37**	100
9	99.2	**38**	100
10	99.2	**39**	100
11	99.0	**40**	100
12	98.8	**41**	100
13	100	**42**	100
14	100	**43**	100
15	100	**44**	100
16	100	**45**	100
17	100	**46**	100
18	100	**47**	100
19	100	**48**	100
20	100	**49**	100
21	100	**50**	100
22	100	**51**	100
23	100	**52**	100
24	100	**53**	100
25	100	**54**	100
26	100	**55**	100
27	100	**56**	100
28	100	**57**	100
29	100	**58**	100

Table A.3 Response Rates of the 7th Grade Student Questionnaire

Item #	Response Rate	Item #	Response Rate
1	99.2	**30**	99.3
2	99.2	**31**	99.2
3	98.9	**32**	99.1
4	98.9	**33**	99.2
5	98.9	**34**	99.2
6	99.1	**35**	99.2
7	99.1	**36**	99.2
8	98.9	**37**	99.3
9	99.1	**38**	99.2
10	99.1	**39**	99.2
11	99.0	**40**	99.2
12	98.7	**41**	99.2
13	99.2	**42**	99.1
14	99.1	**43**	99.1
15	99.2	**44**	99.1
16	98.7	**45**	99.0
17	99.1	**46**	99.1
18	99.2	**47**	98.9
19	99.2	**48**	99.0
20	99.2	**49**	99.1
21	99.1	**50**	98.9
22	99.1	**51**	98.9
23	99.1	**52**	99.0
24	99.0	**53**	98.9
25	99.0	**54**	98.9
26	99.0	**55**	98.9
27	99.0	**56**	98.8
28	98.8	**57**	98.8
29	98.9	**58**	98.8

Table A.4 Response Rates of the 8th Grade Student Questionnaire

Item #	Response Rate	Item #	Response Rate
1	99.3	**30**	99.2
2	99.2	**31**	99.3
3	99.0	**32**	99.2
4	99.0	**33**	99.3
5	99.0	**34**	99.2
6	99.3	**35**	99.2
7	99.1	**36**	99.2
8	99.1	**37**	99.3
9	99.2	**38**	99.2
10	99.2	**39**	99.2
11	99.2	**40**	99.3
12	98.9	**41**	99.2
13	99.2	**42**	99.3
14	99.2	**43**	99.2
15	99.3	**44**	99.2
16	99.0	**45**	99.1
17	99.1	**46**	99.2
18	99.2	**47**	99.1
19	99.2	**48**	99.0
20	99.1	**49**	99.2
21	99.2	**50**	99.1
22	99.1	**51**	99.2
23	99.1	**52**	99.2
24	99.0	**53**	99.1
25	99.1	**54**	99.0
26	99.1	**55**	99.1
27	99.1	**56**	99.0
28	98.9	**57**	98.9
29	99.1	**58**	98.9

APPENDIX B

SIMPLIS Syntaxes for the Mathematics and Geometry Achievement Models

The SIMPLIS codes of the present study for all grade levels will be given as:

1. SIMPLIS Syntax for the Mathematics and Geometry Achievement Model of 6th Grade Students

Factors Affecting Mathematics and Geometry Achievement of 6th Grade Students

Observed Variables
NM8 NM11 NM18 NM19 NM2 NM7 NM13
MOTH_EDU FATH_EDU DISH_WSH OWN_DESK
INT_MATH INT_SCI SUC_MATH SUC_SCI
STU_DISC STU_LESS STU_GRPW STU_DIST
TEA_LESS TEA_SAMP TEA_MAT TEA_LIFE
Covariance Matrix from file: 'D:\TEZ\6\6S.COV'

Sample Size = 10127

Latent Variables
MATH_ACH GEO_ACH SES INT_SUC STU_CENT TEA_CENT

Relationships
NM8 NM11 NM18 NM19 = MATH_ACH
NM2 NM7 NM13 = GEO_ACH

MOTH_EDU FATH_EDU DISH_WSH OWN_DESK = SES
INT_MATH INT_SCI SUC_MATH SUC_SCI = INT_SUC
STU_DISC STU_LESS STU_GRPW STU_DIST = STU_CENT
TEA_LESS TEA_SAMP TEA_MAT TEA_LIFE = TEA_CENT
MATH_ACH = SES INT_SUC STU_CENT TEA_CENT
GEO_ACH = SES INT_SUC STU_CENT TEA_CENT
MATH_ACH = GEO_ACH
Set Error Covariance of SUC_SCI and INT_SCI free
Set Error Covariance of INT_SCI and INT_MATH free
Set Error Covariance of FATH_EDU and MOTH_EDU free
Set Error Covariance of STU_LESS and STU_DISC free
Set Error Covariance of STU_GRPW and STU_DISC free
Set Error Covariance of SUC_SCI and INT_MATH free
Set Error Covariance of DISH_WSH and MOTH_EDU free
Set Error Covariance of STU_DIST and STU_GRPW free
Set Error Covariance of TEA_SAMP and TEA_LESS free

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

End of Problem

2. SIMPLIS Syntax for the Mathematics and Geometry Achievement Model of 7th Grade Students

```
Factors Affecting Mathematics and Geometry Achievement of 7th Grade
Students

Observed Variables
NM4 NM14 NM20 NM6 NM9 NM13
MOTH_EDU FATH_EDU NUM_BOOK DISH_WSH
INT_MATH INT_SCI SUC_MATH SUC_SCI
STU_DISC STU_LESS STU_GRPW STU_DIST
TEA_LESS TEA_SAMP TEA_MAT TEA_LIFE
Covariance Matrix from file: 'D:\TEZ\7\7S.COV'

Sample Size = 9566

Latent Variables
MATH_ACH GEO_ACH SES INT_SUC STU_CENT TEA_CENT

Relationships
NM4 NM14 NM20 = MATH_ACH
NM6 NM9 NM13 = GEO_ACH
MOTH_EDU FATH_EDU NUM_BOOK DISH_WSH = SES
INT_MATH INT_SCI SUC_MATH SUC_SCI = INT_SUC
STU_DISC STU_LESS STU_GRPW STU_DIST = STU_CENT
TEA_LESS TEA_SAMP TEA_MAT TEA_LIFE = TEA_CENT
MATH_ACH = SES INT_SUC STU_CENT TEA_CENT
GEO_ACH = SES INT_SUC STU_CENT TEA_CENT
MATH_ACH = GEO_ACH
Set Error Covariance of SUC_SCI and INT_SCI free
Set Error Covariance of INT_SCI and INT_MATH free
```

Set Error Covariance of FATH_EDU and MOTH_EDU free
Set Error Covariance of STU_DIST and STU_GRPW free
Set Error Covariance of TEA_SAMP and TEA_LESS free
Set Error Covariance of NUM_BOOK and MOTH_EDU free

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

End of Problem

3. SIMPLIS Syntax for the Mathematics and Geometry Achievement Model of 8th Grade Students

```
Factors Affecting Mathematics and Geometry Achievement of 8th Grade
Students

Observed Variables
NM2 NM9 NM20 NM6 NM16 NM17
MOTH_EDU FATH_EDU NUM_BOOK OWN_DESK
INT_MATH INT_SCI SUC_MATH SUC_SCI
STU_DISC STU_LESS STU_GRPW STU_DIST
TEA_LESS TEA_SAMP TEA_MAT TEA_LIFE
Covariance Matrix from file: 'D:\TEZ\8\8S.COV'

Sample Size = 9350

Latent Variables
MATH_ACH GEO_ACH SES INT_SUC STU_CENT TEA_CENT

Relationships
NM2 NM9 NM20 = MATH_ACH
NM6 NM16 NM17 = GEO_ACH
MOTH_EDU FATH_EDU NUM_BOOK OWN_DESK = SES
INT_MATH INT_SCI SUC_MATH SUC_SCI = INT_SUC
STU_DISC STU_LESS STU_GRPW STU_DIST = STU_CENT
TEA_LESS TEA_SAMP TEA_MAT TEA_LIFE = TEA_CENT
MATH_ACH = SES INT_SUC STU_CENT TEA_CENT
GEO_ACH = SES INT_SUC STU_CENT TEA_CENT
MATH_ACH = GEO_ACH
Set Error Covariance of SUC_SCI and INT_SCI Free
Set Error Covariance of INT_SCI and INT_MATH Free
```

Set Error Covariance of FATH_EDU and MOTH_EDU Free
Set Error Covariance of STU_DIST and STU_GRPW Free
Set Error Covariance of TEA_SAMP and TEA_LESS Free
Set Error Covariance of SUC_SCI and INT_MATH Free

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

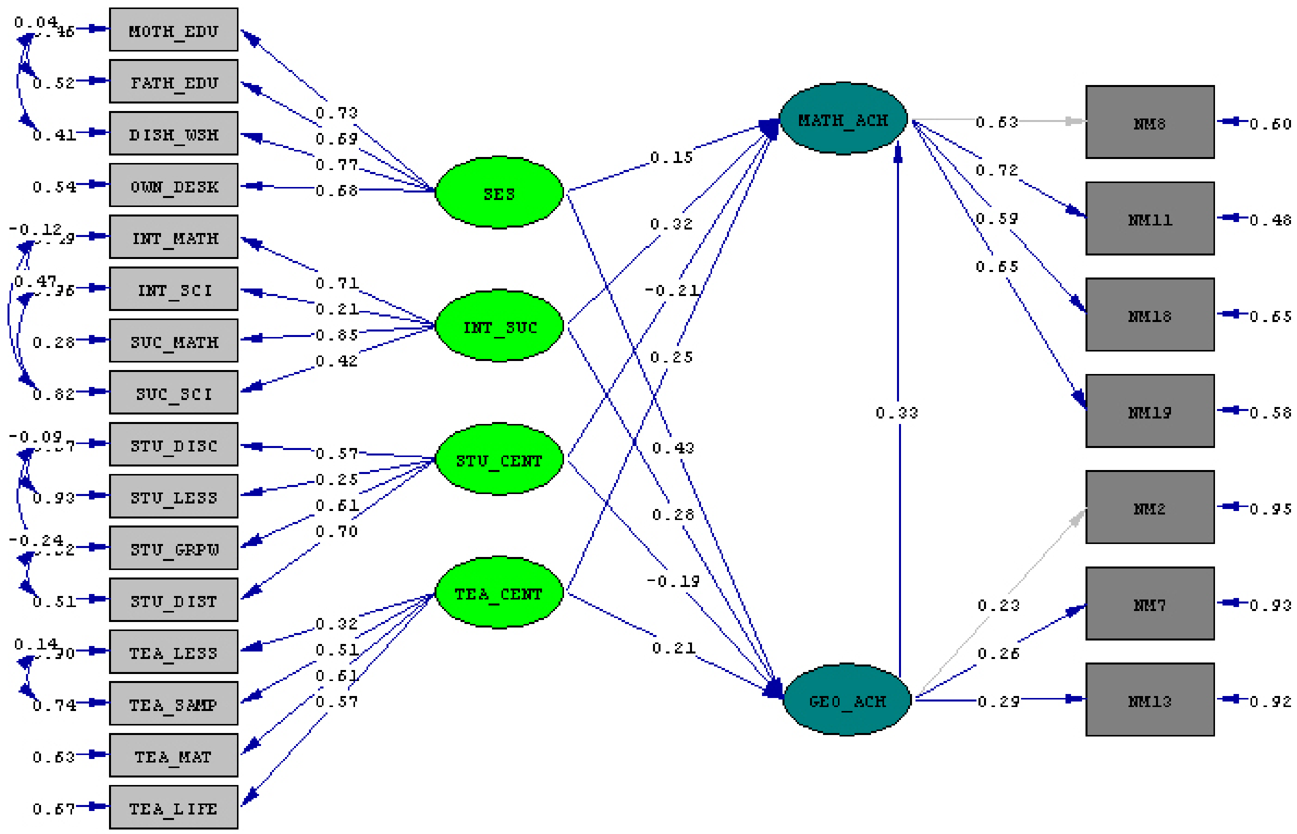
End of Problem

APPENDIX C

LISREL Estimates of Parameters in Measurement Models

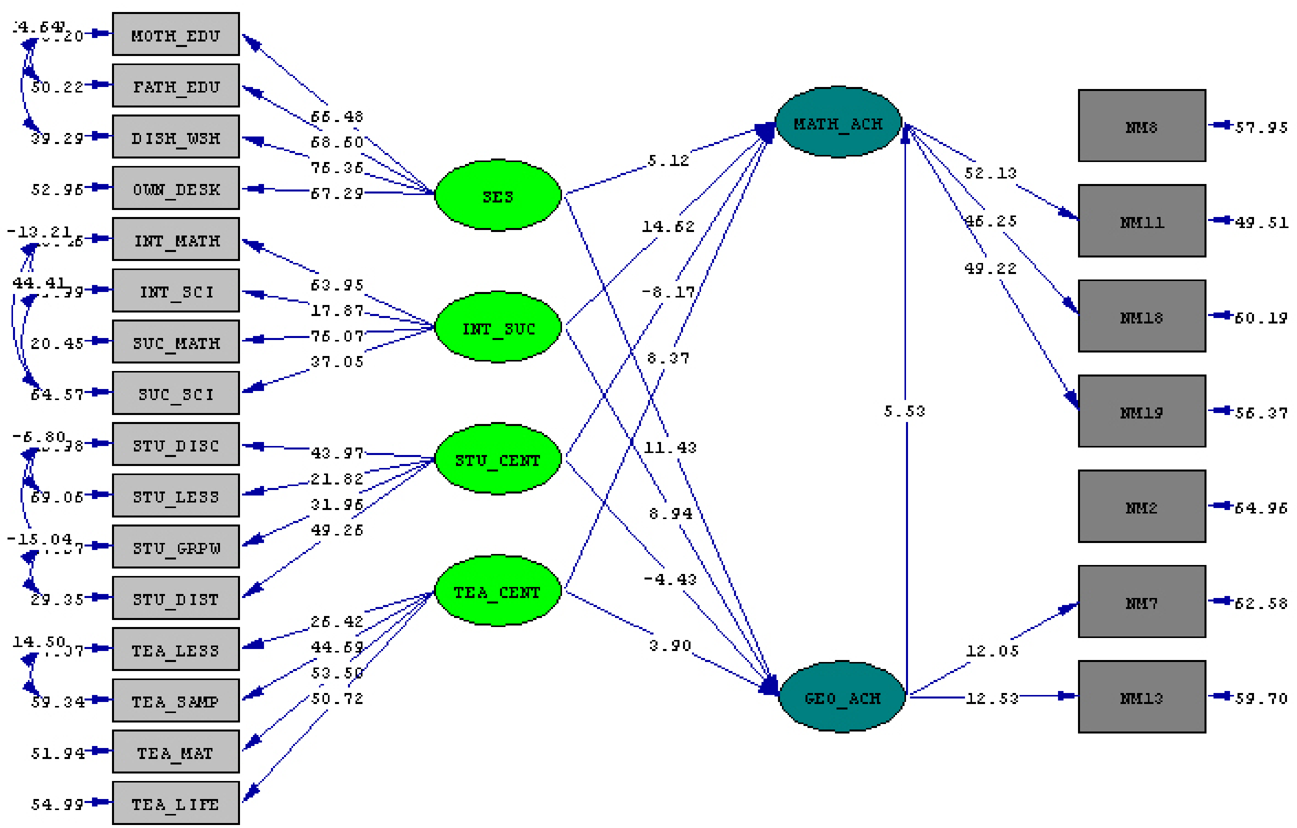
Appendix B includes,

1. The LISREL estimates of parameters in measurement model of 6th grades with coefficients in standardized values,
2. The LISREL estimates of parameters in measurement model of 6th grades with coefficients in t-values,
3. The LISREL estimates of parameters in measurement model of 7th grades with coefficients in standardized values,
4. The LISREL estimates of parameters in measurement model of 7th grades with coefficients in t-values,
5. The LISREL estimates of parameters in measurement model of 8th grades with coefficients in standardized values,
6. The LISREL estimates of parameters in measurement model of 8th grades with coefficients in t-values.



Chi-Square=1941.99, df=206, P-value=0.00000, RMSEA=0.029

Figure B.1 Basic Model of 6th Grade Students with Coefficients in Standardized Values



Chi-Square=1941.99, df=206, P-value=0.00000, RMSEA=0.029

Figure B.2 Basic Model of 6th Grade Students with Coefficients in t-Values

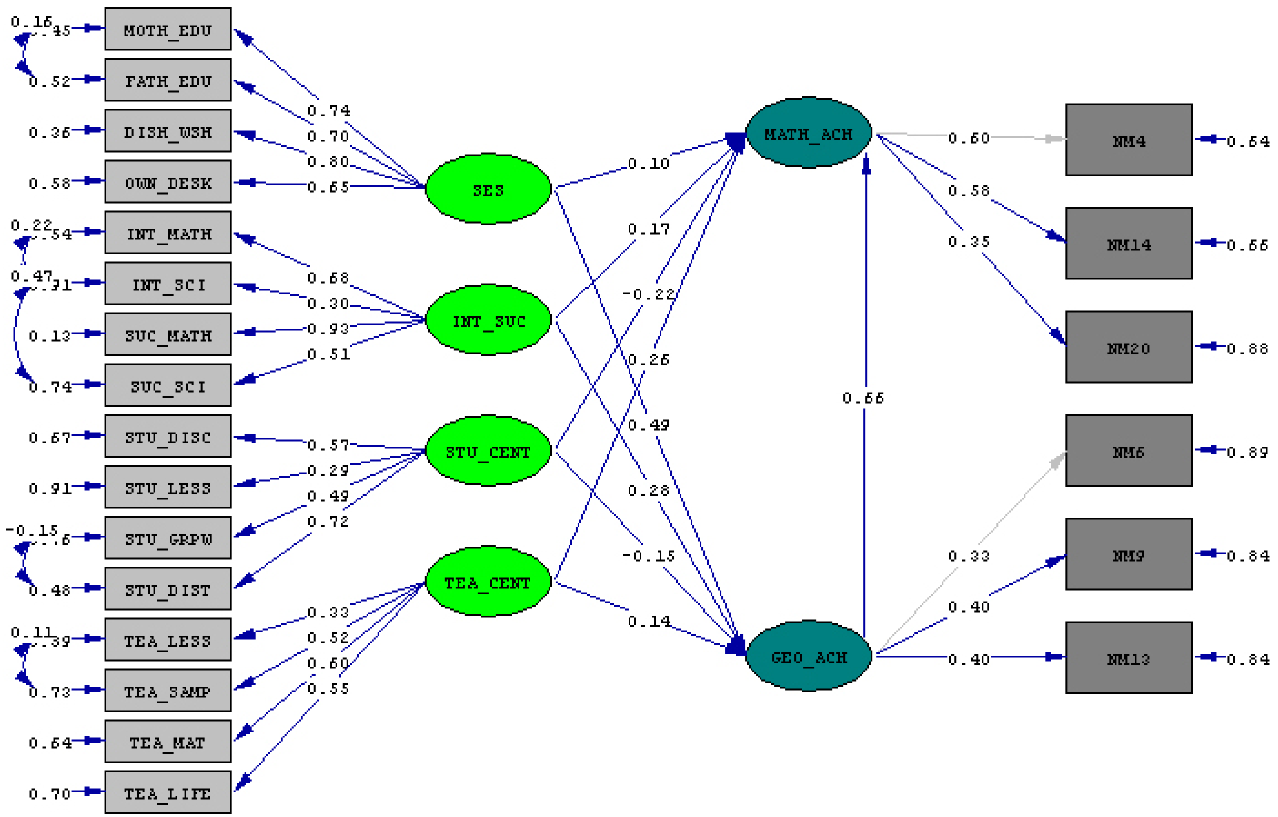


Figure B.3 Basic Model of 7th Grade Students with Coefficients in Standardized Values

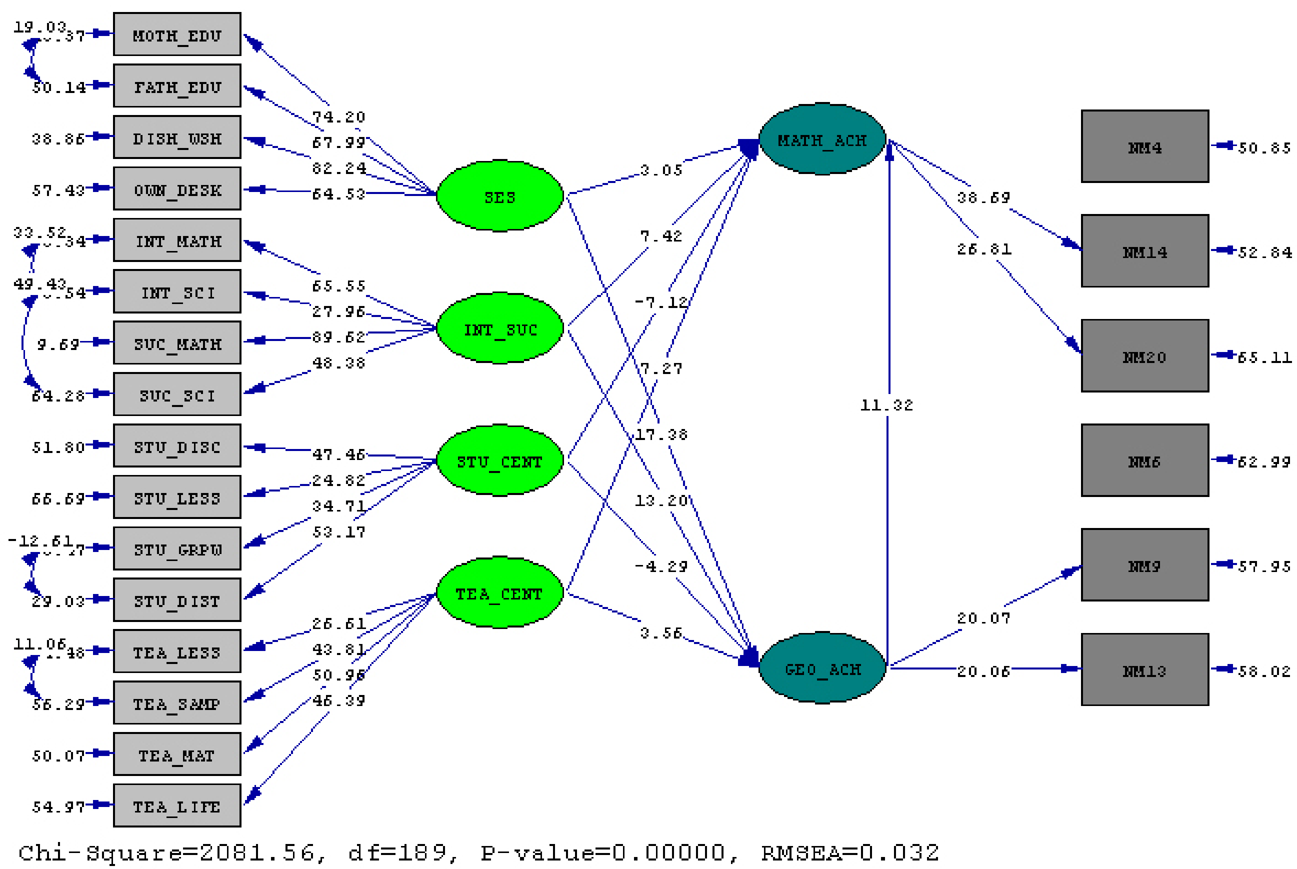
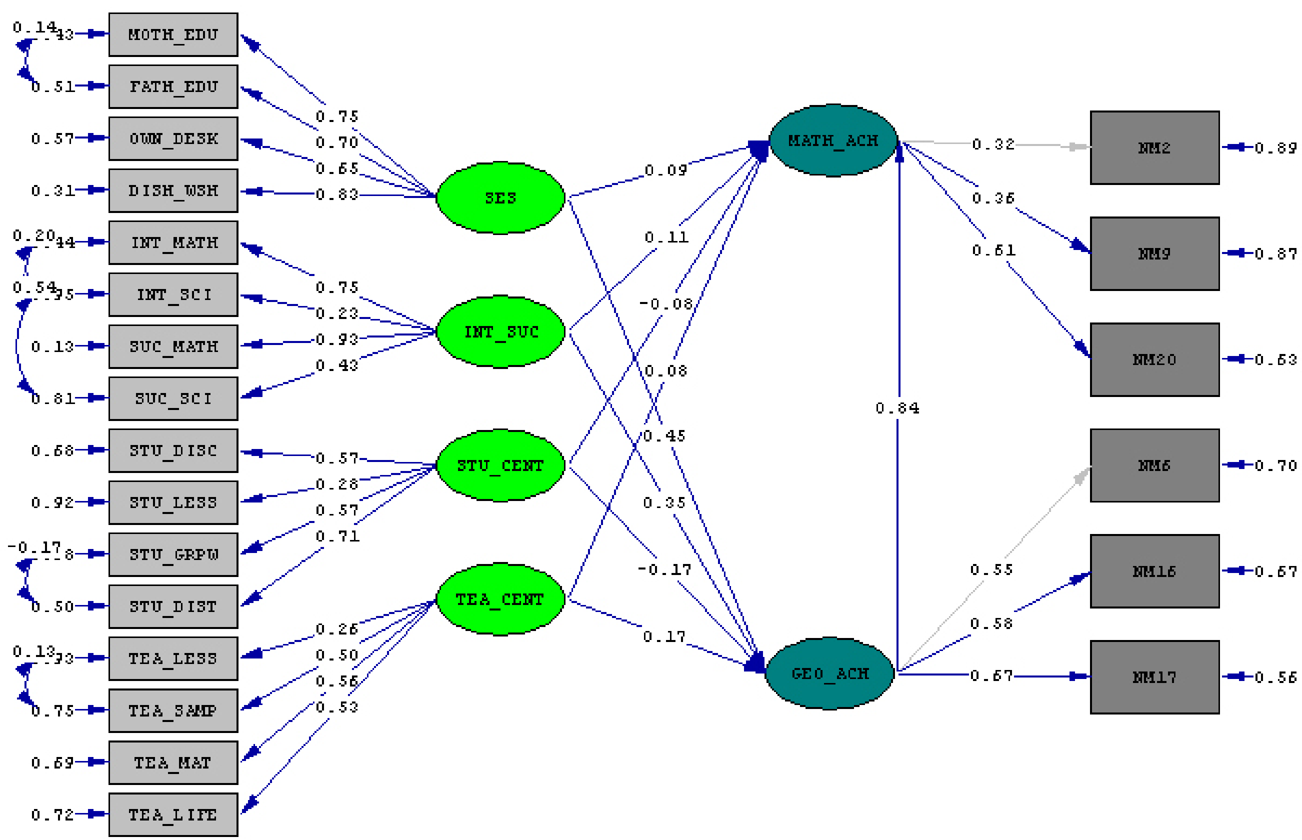


Figure B.4 Basic Model of 7th Grade Students with Coefficients in t-Values



Chi-Square=2648.12, df=189, P-value=0.00000, RMSEA=0.037

Figure B.5 Basic Model of 8th Grade Students with Coefficients in Standardized Values

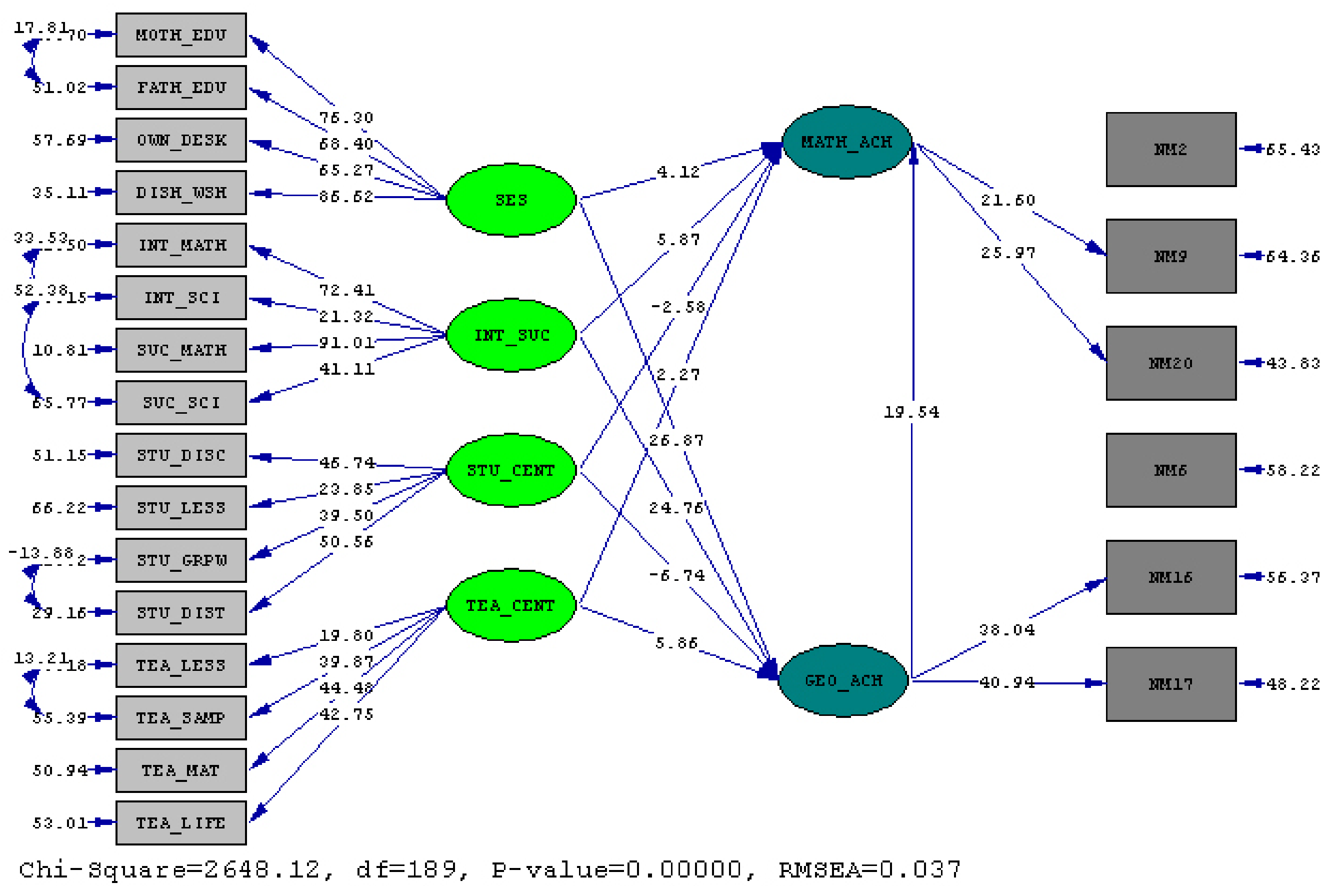


Figure B.6 Basic Model of 8th Grade Students with Coefficients in t-Values