RECIPROCAL RELATIONSHIP BETWEEN ATTITUDES TOWARD MATHEMATICS AND ACHIEVEMENT IN MATHEMATICS

A THESIS SUBMITTED TO

THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

OF

MIDDLE EAST TECHNICAL UNIVERSITY

BY

93407

ŞENAY TAĞ

IN PARTIAL FULFILLMENT OF REQUIREMENTS FOR

THE DEGREE OF MASTER OF SCIENCE

IN

DEPARTMENT OF SECONDARY SCIENCE AND

MATHEMATICS EDUCATION

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

OCTOBER 2000

Approval of the Graduate School of Natural and Applied Sciences

Prof. Dr. Tayfur ÖZTÜRK

Director

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

Prof. Dr.Yaşar ERSOY

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

Dr. Safure BULUT

Supervisor

Examining Committee Members

Prof. Dr. Petek AŞKAR

Prof. Dr. Giray BERBEROĞLU

Prof. Dr. Yaşar ERSOY

Assist. Prof. Dr. Ahmet ARIKAN

Dr. Safure BULUT

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

ABSTRACT

RECIPROCAL RELATIONSHIP BETWEEN ATTITUDES TOWARD MATHEMATICS AND ACHIEVEMENT IN MATHEMATICS

Tağ, Şenay

M.Sc. Department of Secondary Science and Mathematics Education

Supervisor: Dr. Safure Bulut

October 2000, 105 pages

The purposes of the study was to model reciprocal relationship between attitude toward mathematics (ATM) and achievement in mathematics (AIM) including teacher, father and mother qualities.

Subject of the study consisted of 9th grade students in Türk Eğitim Derneği Vakfı Ankara College, Gazi Anatolian Lyceé, Mehmet Emin Resulzade Anatolian Lyceé, Kılıçaslan Lyceé, Niğbolu Lyceé.

The following measuring instruments were utilised: 1) Mathematics Achievement Test (MAT), and 2) Scales: (i) Father Scale, (ii) Mother Scale, (iii) Teacher Scale I, (iv) Teacher Scale II, (v) Confidence in Learning Mathematics Scale, (vi) Success Attribution in Mathematics Scale, (vii) Usefulness of Mathematics Scale, (viii) Mathematics as a Male Domain Scale, (ix) Effectance Motivation Scale, (x) Mathematics Anxiety Scale, (xi) Importance of Mathematics Scale.

The researcher developed MAT. Teacher Scale II formed by adaptation of the TIMSS Attitude Scale (1999) and the other scales were formed by adapting Fennema-Sherman Attitude Scale (1986). The validty and reliability of the measuring instruments were tested by the researcher.

The data of this study were analysed by using Linear Structural Equation Modelling (LISREL). The results were as follows: (1) There was reciprocal relationship between attitudes toward mathematics (ATM) and achievement in mathematics (AIM); (2) Confidence in learning mathematics, success attribution in mathematics, mathematics anxiety, importance of mathematics, effectance motivation, usefulness of mathematics positively and significantly loaded on ATM; (3) Mathematics as a male domain negatively and significantly loaded on ATM; (4) Mathematics as a male domain positively and significantly loaded on AIM; (5) Teacher quality had a positive statistically significant direct effect on both ATM and AIM; (6) Father quality had a positive statistically significant direct effect on both ATM and AIM; (7) Mother quality had a positive statistically significant direct effect on AIM; (8) Mother quality had a negative statistically significant direct effect on ATM.

Key Words: Achievement in Mathematics, Attitudes Toward Mathemtaics, Reciprocal Relationship, Linear Structural Equation Modeling.

ÖZ

MATEMATİĞE YÖNELİK TUTUM İLE MATEMATİK BAŞARISI ARASINDAKİ KARŞILIKLI İLİŞKİ

Tağ, Şenay
Yüksek Lisans, Orta Öğretim Fen ve Matematik Alanları Eğitimi Bölümü
Tez Yöneticisi: Dr. Safure Bulut

Ekim 2000, 105 sayfa

Bu çalışmanın amacı, matematik başarısı ve matematiğe yönelik tutum arasındaki karşılıklı ilişkinin öğretmen, baba ve anne niteliklerini içererek modellenmesidir.

Araştırmaya katılan kişiler, TED Ankara Koleji, Gazi Anadolu Lisesi, Mehmet Emin Resülzade Anadolu Lisesi, Kılıçaslan Lisesi ve Niğbolu Lisesi dokuzuncu sınıf öğrencileridir.

Bu araştırmada Matematik Başarı Testi ile Ölçekler: (i) Baba Ölçeği, (ii) Anne Ölçeği, (iii) Öğretmen Ölçeği I, (iv) Öğretmen Ölçeği II, (v) Matematik Öğrenmede Kendine Güven Ölçeği, (vi) Matematik Başarısına Yönelik Tutum Ölçeği, (vii) Matematiğin Kullanışlılığı Ölçeği, (viii) Erkek Alanı Olarak Matematik Ölçeği, (ix) Matematikte Başarma Güdüsü Ölçeği, (x) Matematik Kaygısı Ölçeği ve (xi) Matematiğin Önemi Ölçeği. Matematik Başarı Testi araştırmacı tarafından geliştirilmiştir. Öğretmen Ölçeği I, Üçüncü Uluslararası Matematik ve Fen

Çalışmaları (TIMSS) Tutum Ölçeğinden uyarlanmıştır. Diğer ölçme araçları Fennema-Sherman Tutum Ölçeğinden uyarlanmıştır. Ölçme araçlarının geçerlilik ve güvanilirlik çalışmaları araştırmacı tarafından yapılmıştır.

Veriler, Lineer Yapısal Denklem Modeli (Linear Structural Equation Modelling) ile analiz edilmiştir. Bu çalışmanın sonuçları şunlardır: (1) Matematik başarısı ile matematiğe yönelik tutum arasında karşılıklı bir ilişki bulunmuştur; (2) Matematik öğrenmede kendine güven, matematik başarısına yönelik tutum, matematiğin kullanışlılığı, matematik kaygısı, matematik başarısı, matematikte başarma güdüsü, matematiğe yönelik tutumu pozitif ve istatistiksel olrak anlamlı bir şekilde tanımlanmıştır; (3) Erkek alanı olarak matematik, matematiğe yönelik tutumu negatif ve istatiksel olarak anlamlı bir şekilde tanımlamıştır; (4) Erkek alanı olarak matematik, matematik başarısını pozitif ve istatistiksel olarak anlamlı bir şekilde tanımlanmıştır; (5) Öğretmen niteliği, matematiğe yönelik tutumu ve matematik başarısını pozitif ve doğrudan istatistiksel olarak anlamlı bir şekilde etkilemiştir; (6) Baba niteliği, matematiğe yönelik tutumu ve matematik başarısını pozitif ve doğrudan istatistiksel olarak anlamlı bir şekilde etkilemiştir; (7) Anne niteliği, matematiğe matematik başarısını pozitif ve doğrudan istatistiksel olarak anlamlı bir şekilde etkilemiştir; (8) Anne kalitesi, matematiğe yönelik tutumu negatif ve doğrudan istatistiksel olarak anlamlı bir şekilde etkilemiştir

Anahtar Kelimeler: Matematik Başarısı, Matematiğe Yönelik Tutum, Karşılıklı İlişki, Lineer Yapısal Denklem Modeli

ACKNOWLEDGEMENTS

I wish to express my gratitude to Dr. Safure Bulut for their patient, guidance, and warm supports throughout the study. Without their valuable and extensive suggestions, continuos encouragement, and constructive criticism this study would not have reached to its present condition.

I would like to thank Prof. Dr. Giray Berberoğlu for his contributions to the study.

I wish to thank Aykut İnan İşeri for his help and encouragement during the study.

I would like to thank teachers and students of TED College, Gazi Anatolian Lyceé, Kılıçaslan Lyceé, Niğbolu Lyceé, and MERAL for their help during application of the measurement instruments.

I would like to thank Gürkan Gürler for his great encouragement and moral support.

I also thank my mother and my sister who shared all the stresses and difficulties during my study.

I am also thankfull to the Middle East Technical University for the financial support of this research under the grant AFP 99.05.01.06.

TABLE OF CONTENTS

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

LIST OF TABLES

TABLE

LIST OF FIGURES

FIGURE

LIST OF ABBREVIATIONS

ATM: Attitudes toward mathematics
AIM: Achievement in mathematics
MathATS: Mathematics Achievement Test Score
conf : Confidence in learning mathematics
success: Success attribution in mathematics
maledo : Math as a male domain
use: Usefulness of mathematics
anx : Anxiety in mathematics
imp: Importance of mathematics
efmo: Effectance motivation
PteChSt: Percieved Characteristics of Teacher Related to Students
PteChTP: Percieved Teacher Characteristics Related to Profession
PmoChSt: Percieved Mother Characteristics Related to Students
PfaChSt: Percieved Father Charecteristics Related to Students
fathedl: Father Education Level
mothedl : Mother Education Level
DETQAIM: Direct Effect of Teacher Quality on Achievement in Mathematics
IETQAIM: Inderect Effect of Teacher Quality on Achievement in Mathematics
DETQATM: Direct Effect of Teacher Quality on Attitudes toward Mathematics
IETQATM: Inderect Effect of Teacher Quality on Attitudes toward Mathematics
DEMQAIM: Direct Effect of Mother Quality on Achievement in Mathematics
IEMQAIM: Inderect Effect of Mother Quality on Achievement in Mathematics
DEMQATM: Direct Effect of Mother Quality on Attitudes toward Mathematics
IEMQATM: Inderect Effect of Mother Quality on Attitudes toward Mathematics
DEFQAIM: Direct Effect of Father Quality on Achievemnt in Mathematics

IEFQAIM: Inderect Effect of Father Quality on Achievemnt in Mathematics
DEFQATM: Direct Effect of Father Quality on Attitudes toward Mathematics
IEFQATM: Inderect Effect of Father Quality on Attitudes toward Mathematics

CHAPTER 1

INTRODUCTION

Knowledge of the mathematics has been described as the "critical filter " for entrance into many occupations. Lack of mathematical knowledge prohibits many from participating in careers that would be economically rewarding as well as psychologically satisfying. The explanation of the failure of many to obtain this mathematical knowledge is complex and poorly understood. It is known, however, that an increasing number of students who are qualified intellectually are deciding not to study mathematics, and many more girls than boys make this decision. Attitudes toward mathematics affect both selecting to study mathematics and its learning.

A number of researchers have investigated the relationship between achievement in mathematics (AIM) and attitude toward mathematics (ATM) (Aiken, 1971 & 1976; Abrego, 1966; Wolf and Blixt, 1981; Randhava & Beamer, 1982; Revicki, 1982; Minato & Yenase, 1984; Feather, 1988; Kloosterman, 1991; Ma & Kishor, 1997; Ma, 1997). However, the research literature has failed to provide consistent findings regarding the relationship between ATM and AIM. A number of researcher have demonstrated that the ATM - AIM correlations quite low, ranging from zero to 0.25 in absolute value, and they have concluded that the ATM - AIM relationship is weak and con not be considered to be of practical significance (Abrego, 1966; Wolf & Blixt, 1981). Robinson (1975) concluded that AIM accounts for, at best, 15 % of the variance in AIM, indicating that the relationships have no useful implication for educational practice.

On the other hand, Enemark and Wise (1981) demonstrated that "the attitudinal variables are significant indicators of mathematics achievement and few of the attitudinal variables also showed strong relationship with math achievement even after background and academic criterion variables are controlled. Steinkamp (1982) concluded that primary variable that determine AIM is ATM. These conclusions represent the views of a strong relationship between ATM and AIM with correlation above 0.40, as supported by a number of researchers (Kloosterman, 1991; Minato, 1983; Minato and Yanase, 1984).

Still other findings show that although the ATM - AIM relationship is statistically significant, it is not very strong from a practical perspective, with correlations ranging from 0.20 to 0.40 in absolute value (Aiken 1970a). He stated that "the correlations between attitude and achievement in elementary school, though statistically significant in certain instances, are typically very large. Later, Aiken (1976) noted that the ATM - AIM relationship is usually positive and meaningful at the elementary and secondary school levels, but may not always reach statistical significance.

Unfortunately, mathematics educators have done little to investigate causal relationship between ATM and AIM. That is, more positive ATM contributes to a higher level of AIM. Most studies use correlation coefficients as a measure of the relationship and therefore do not provide clear evidence in regard to whether ATM is cause or an effect of AIM (Enemark and Wise, 1981; Neale, 1969). Quin and Jadav (1987) argued that distinctions ought to be made between a reciprocal ATM - AIM relationship and a causal ATM - AIM relationship. Although researchers have published studies on the causal relationship between ATM - AIM (e.g. Ethington and Wolfle, 1984, 1986) they tented to conduct them from a unidirectional perspective. Ethington and Wolfle (1984,1986) proposed structural equation model of mathematics achievement in which ATM is specified to cause AIM.

Moreover, the weak causal relationship between ATM and AIM might be due to the attempt of researchers to search for a direct cause –effect relationship between

T.C. YÜKSEKÖĞRETIM KURULU
DOKÜMANTASYON MERKEZİ

attitude and achievement. It is very likely that previous researchers omitted certain indirect causes in their examinations of the causal relationship. There may still be meaningful effect size on the causal relationship if researchers combine direct and indirect effects of ATM on AIM. So, taking into account the potential mediating variables between ATM and AIM may produce better results.

In addition, there is still little evidence that previous researchers seriously recognised that attitude and achievement interact with each other in complex an unpredictable ways (Mcleod, 1992). In their study, Ethington and Wolfle (1986) argued that enrollment in mathematics courses is likely to affect attitudes toward mathematics and these attitudes affect decision to enroll in mathematics courses. Thus, specifying any unidirectional causal relationship between ATM and AIM would be not appropriate. In line with this argument, Feather (1988) examined a bilateral relationship between mathematics ability and mathematics valance. Revicki (1982) investigated the reciprocal effects between mathematics self-concept and mathematics achievement. Ma (1997) studied on the reciprocal relationship between attitudes toward mathematics (ATM) and achievement in mathematics (AIM). He took father education level, mother education level, sex, importance of math, difficulty of mathematics. enjoy with mathematics as observed variables, ATM and AIM as latent variables.

However, to get the whole picture of the reciprocal relationship between ATM and AIM those variables are not enough. Besides them the other variables can be stated as teachers' attitudes toward mathematics and teaching mathematics, mathematics anxiety, confidence in learning mathematics, success attribution, parents' attitude toward mathematics and their expectations from child about learning mathematics.

Teacher's attitudes and effectiveness in mathematics viewed as being prime determiners of students' attitudes and performance in subject (Garner, 1963; Torrance, 1966; Fennema. Peterson, Carpenter & Lubinski, 1990; Karp, 1991; Austin & Wodlington, 1992; Carter & Norwood, 1997).

Fey (1980) claimed that although teachers' knowledge of mathematics and how to teach it was important, their beliefs about mathematics teaching had equal impact on students. In addition, Thompson (1984) found that teachers' beliefs about mathematics do influence how they teach mathematics. The teacher who feels insecure, who dreads and dislikes subject, can not avoid transmitting her feelings to the children. Moreover, studies of Carpenter and Lubinski (1990) have indicated that teacher attitudes towards a subject influence both the instructional techniques they use and that these in turn may have an effect on pupil attitudes.

It is important to determine direction and strength of the effects of teacher attitudes and effectiveness in mathematics on student's attitudes toward mathematics and achievement in mathematics. That can help teacher education institutions and school district administrators to develop programs to help pre- and in-service teachers to recognise and overcome the problem of negative attitudes toward mathematics and instructional consequences of these attitudes. Such programs would ultimately help the teachers themselves and the students whom they teach over many years.

Besides, teachers' attitudes and effectiveness in mathematics, the students' family background is influential in learning even in the subject of mathematics, which may appear to be learned exclusively in school (Proffenberger & Norta, 1959; Alper, 1963; Hill, 1967; Hattie, 1984; Wang, Wildman & Callahun, 1996).

Since about 85 percent of the student's educative hours between birth and age 18 are at least nominally controlled by parents rather than educators the home is a critical on the amount learned. According to Poffenberger and Norton (1959), parents affected the child's attitude and performance in three ways: (1) by parental expectations of child's achievement; (2) by parental encouragement; (3) by parents' own attitudes toward mathematics. So educators and parents can cooperate to increase the intellectually supportive conditions and encourage perseverance in the home, then achievement is likely to rise proportionately. Improving attitude and encouraging great learning are both important for long-term results. Therefore, with the identification of direction and strength of parents' effect on students' attitudes toward mathematics and achievement in mathematics, educators will provide appropriate guidelines to parents.

In addition to teachers' attitudes toward mathematics and teaching of mathematics, and parents, there is an increasing recognition that affective factors play a critical role in teaching and learning of mathematics (Reyes, 1984). One factor that has probably received more attention than any other area in the affective domain is anxiety toward mathematics. Educators usually link poor mathematics achievement, discomfort with mathematics, negative attitudes toward mathematics, avoidance of mathematics tasks with the construct of anxiety toward mathematics (Drager & Aiken, 1957; Alpert, Stellwagen & Becker, 1963; Degnan, 1967; Carpenter, 1980; Holden, 1987). Studies on mathematics anxiety provide some general conclusions about the relationship between mathematics anxiety, mathematics achievement and attitudes toward mathematics. Negative relationship has been found between these variables, so that high achievement and positive attitudes toward mathematics is related to low anxiety for students from grade school through college (Aiken, 1976; Mecce, Wigfield & Eccless, 1990; Ma, 1999). Hence, including mathematics anxiety will enlighten the relationship between mathematics anxiety and achievement in mathematics and attitudes toward mathematics. Results of the present study may help teachers become aware of the problems of anxious students; they will focus on causes, effects, and remedies of mathematics anxiety. Educators will develop treatment programs to help students to manage their emotional stress.

Confidence is another important affective variable. Confident students tend to learn more, feel better about themselves, and be more interested in pursuing mathematical ideas than students who lack of confidence (Reyes, 1984). How sure a person is of being able to learn new topics in mathematics, perform well in mathematics class, and do well in mathematics tests are used to refer confidence in learning mathematics (Fennema & Peterson, 1983; Reyes, 1984). People who are sure of their ability in mathematics will probably choose tasks involving mathematics more often end persist longer than those who are not sure they will succeed. Crosswhite (1972) found that positive correlation between confidence and mathematics achievement. Fennema and Sherman (1977&1978) studied the relationship between confidence in mathematics and mathematics achievement for students 6-12. They found that positive relationship between mathematics achievement and confidence as measured by the Fennema Sherman Confidence Scale. Amstrong (1980) and Dawling (1978) found relatively strong relationship between confidence in learning mathematics and achievement in mathematics.

Research studies on confidence in learning mathematics indicate the importance of this variable in relation to student achievement. Thus, inclusion of this affective variable in the study may clarify its relationship with achievement in mathematics.

Besides mathematics anxiety and confidence in learning mathematics, attribution is a helpful means of examining the details of student motivation and achievement in schools. Mathematics education studies on concerning attribution deal with students' and teachers' perceptions of the causes of student success or failure on mathematics tasks. They have been done mainly to help and understand students' achievement in mathematics. Studies of attribution have examined how percieved causes of success and failure are related to academic achievement (Reyes, 1984). There is a well established relationship between attribution and achievement related behaviours such as persistence, effort and choice of challenging tasks. When a person perceives the cause of success and failure as stable (ability or task difficulty); the change in expectations will be greater than when unstable factors (effort or luck) are seen as the cause. According to Weiner (1974) when success is attributed to good luck. the increase in expectancy for future success in that situation will be smaller than if the success had been attributed to ability or ease of the task. Similarly, when failure is seen as caused by low ability, the drop in expectancy for future performance is greater than when failure is attributed to lack of effort or bad luck. So, including attribution as variable in the study may further our understanding of why certain students succeed or fail in mathematics in Turkey. Identifying role of attribution in mathematics achievement may help teachers to develop ways to reduce attribution that produce learned helpless.

However, a major reason for studying affective factors (mathematics anxiety, confidence in learning mathematics, success attribution) in mathematics education is to find ways to help students learn more mathematics. Another reason to study affective variables is that a positive attitude toward mathematics is an important educational outcome, regardless of achievement level (Reyes, 1984).

Nevertheless, mathematics anxiety, confidence in learning mathematics and success attribution is not only affective variables that are included in the present study. Like Ma's (1997) study importance of the mathematics, mathematics as a male domain are the other included variables.

There has traditionally been a difference between girls and boys in the areas in which they are expected to work for success: boys value achievement in intellectual and leadership areas, whereas girls value work requiring well-developed social skills (Leder, 1992). There is considerable evidence that as early as second grade children view reading, artistic, and social skills as feminine and athletic, spatial-mechanical, and mathematical skills as masculine. Similarly studies indicate that boys prefer leisure activities focused on skills and mastery of objects whereas girls prefer activities that emphasise interpersonal relationships. However, results from the literature are not clear. Some studies have reported that boys display more favourable attitudes toward mathematics than girls do (Kaczala, 1981; Gwizdala & Steinback, 1988; Fennema & Carpenter, 1981; Hanna, 1986; Messer, 1993; Ma, 1995). Other studies, however, reported that girls have more positive attitudes toward mathematics (Dungan & Thurlow, 1989). Moreover, other investigations have reported no significant gender difference with respect to the attitudes toward mathematics (Aiken, 1976; Hilton & Berglund, 1982; Kavrell & Peterson, 1984; Hall & Hoff, 1988).

Since there has been sharp disagreement in the literature regarding the evidence for a boy advantage in mathematics achievement, inclusion of gender as a variable in the present study may provide new insight into relationships achievement in mathematics, gender and attitudes toward mathematics relationship. According to the results of the present study teacher may develop strategies to deal with gender related differences in mathematics achievement and attitudes toward mathematics.

It can be concluded that when attitude scores are used as predictors of achievement in mathematics, a low but significant positive correlation is usually found (Abrego, 1966; Aiken, 1971 & 1976; Wolf & Blixt, 1981; Randhava & Beamer, 1982; Minato & Yenase, 1984; Kloosterman, 1991). Although most studies use correlation coefficients as a measure of the relationship between variables, they do not provide clear evidence in regard to whether attitudes toward mathematics are a cause or an effect of achievement in mathematics. Although researchers have published studies on the causal relationship between attitudes toward mathematics and achievement in mathematics they tended to conduct them from unidirectional perspective (Enemark & Wise, 1981; Steinkamp, 1982; Revicki, 1982; Feather,

DOKÜMANTASYON MERKEZİ

1988; Mcleod, 1992). However, there is a little evidence that unilateral relationship can not capture the interactive characteristics of attitudes toward mathematics and achievement in mathematics. Nevertheless, previous researchers seriously recognised that attitude and achievement interact with each other in complex and unpredictable way and while identifying relationship between ATM and AIM including mediating variables: students' perception of teachers' beliefs about mathematics, attitudes toward mathematics and mathematics achievement, and their expectation; students' perception of parents' encouragement, confidence in their ability, attitudes toward mathematics, and their expectations; mathematics anxiety, confidence in learning mathematics, success attribution in mathematics, beliefs of the students and gender were important (McLeod, 1992; Ma & Kishor,1997; Ma, 1997).

Unfortunately, in Turkey there is no research study on modeling of relationship between achievemnt in mathematics and attitudes toward mathematics. However, there are several research studies on modeling in Science Education and Foreign Language Education (e.g. Tosunoğlu,1993; Berberoğlu, 1995; Süleymanoğlu, 1997; Berberoğlu 1999).

Consequently, in Turkey, it is worth to study on relationship between attitudes toward mathematics (ATM) and achievement in mathematics (AIM) including the identified factors by the previous studies that have important effects on the relationship between ATM and AIM. The basic variables in the examination of this relationship are mother quality, father quality, teacher quality, confidence in learning mathematics, success attribution mathematics, math anxiety, mathematics as a male domain, students' perceptions of usefulness and importance of mathematics, effectance motivation. Thus, the purpose of this study is to model reciprocal relationships between attitude toward mathematics and achievement in mathematics with these selected variables.

CHAPTER 2

REVIEW OF THE LITERATURE

This chapter includes theoretical background and literature review of the present study. First, theoretical background for the variables summarised. Then, the literature related to the present study is reviewed and discussed.

2.1 Theoretical Background

In this section theoretical background for the variables included in the present study was summarised.

2.1.1 Affective Variables

In a review of affective variables, Reyes (1984) identified confidence in learning mathematics, usefulness of mathematics, success attribution related to mathematics, mathematics anxiety as the important affective variables.

2.1.1.1 Confidence in Learning Mathematics

Confidence in learning mathematics refers to ones ability to learn and perform well on mathematical tasks. How sure a student in of his or her ability to learn new mathematics and to do well on mathematical tasks is one part of the self-concept? Confidence influences a student's willingness to approach new material and to persist when the material becomes difficult (Reyes, 1984; Fennema and Peterson, 1989). Confidence in learning mathematics is also reflected course taking and career aspirations in quantitative fields. Researchers have investigated relationship between confidence in learning mathematics and mathematics achievement. Crosswhite (1972) reported that correlations between confidence and mathematics achievement scores ranging from 0.19 to 0.37.

Similarly, Fennema and Sherman (1977,1978) found positive significant correlations between mathematics achievement and confidence as measured by Fennema-Sherman Confidence scale.

However, Bulut (1988) didn't find significant relationship between mathematics self-concept and mathematics achievement of freshman in the Department of Mathematics Education.

In the Bloom's Theory of school Learning confidence is one of the affective variables that affect students' achievement and attitudes toward mathematics (see in Figure 2.1.1).

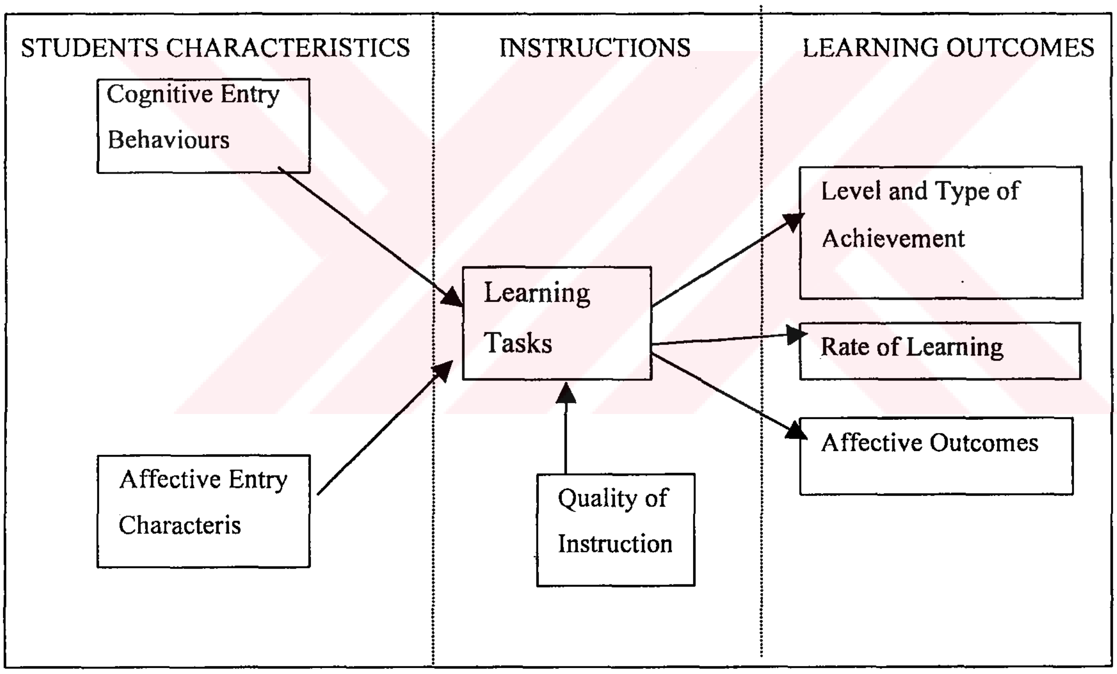


Figure 2.1.1 Bloom's Theory of School Learning

2.1.1.2 Usefulness and Importance of Mathematics

Usefulness of mathematics refers to students' beliefs about the usefulness of mathematics currently and in relationship to their future. Students' perceptions of the usefulness and importance of mathematics, both immediately and in their future, is a variable that have been shown to be strongly associated with mathematics participation and achievement (Fennema & Leder, 1989).

Usefulness of mathematics may, in fact, influence participation on a short-term basis by increasing persistence when the material gets harder. This can be understood within the framework of the Expectancy X Value model of achievement motivation (Atkinson, 1964). In this model motivation to engage in a given task is the product of the student's expectancy of success and his perception of the value of the task. The student confidence, and therefore his expectancy of success, can be low, but a strong perception that mathematics is useful, and therefore valuable, will result in the motivation to continue, despite the difficulty.

A few studies have examined perceptions of usefulness relative to the mathematics participation and achievement. Carpenter and Corbit (1980) found that students percieved mathematics as the useful to themselves as individuals and border concerns of society. Pedro, Wolleat, Fennema, and Becker (1981) considered usefulness and other affective variables as predictors of plans to study high school mathematics. It was found that after prior achievement usefulness was the strongest predictor for both genders. Usefulness of mathematics is the most important reason in deciding to take more mathematics. Lantz and Smith (1981) found that the subjective value placed on mathematics was the attitudinal variable most highly correlated with mathematics participation.

TIMSS (1997) students' perception of importance of mathematics identified as the important attitudinal variable. Ma (1997) also identified importance of mathematics was a kind of awareness or recognition, an attitudinal element that encourage students to put more effort into learning mathematics.

2.1.1.3 Anxiety in Mathematics

Fear of failure or lack of confidence as well as some contextual inhibits understanding and enjoyment in mathematics. Poor mathematics achievement, discomfort with mathematics, negative attitudes toward mathematics, avoidance of mathematics task usually linked with the mathematics anxiety. Mathematics anxiety refers to feelings of anxiety, dread, nervousness and associated bodily symptoms related to doing mathematics.

Byrd (1982) presents a model of the process of anxiety, which she adapted from Spielberger (1972) (see Figure 2.1.2).

Stressor → Perception of Threat → A-state reaction → Cognitive Reappraisal → Coping

Figure 2.1.2 Anxiety as Process from Byrd

The model shows the sequence of responses with which an individual reacts to an anxiety- arousing situation. First, the individual has a stressful experience, which is subsequently percieved as threatening in someway. The perception of threat may come immediately after the stressor or after some time has passed. No anxiety is produced unless the individual is aware of the stressful experience and perceives it as threat. The anxiety reaction itself consists mainly of physiological and behavioural signs associated with the reaction to the stressor. The physiological reaction may include a speeding of heart and breathing rate, tension of muscles, sweaty palms, dilation of pupils, or other responses of the autonomic nervous system. Behavioural reactions are more subject to conscious control by the individual than the physiological ones, may include trembling of the voice, biting of fingernails, or fidgety behaviour. Cognitive appraisal comes after the A-state reaction begins; though the anxiety reaction does not necessarily and when cognitive reappraisal begins. This state consists of selecting a method of coping with the stressor may take variety of forms, involving actions to combat the treat, inaction or defence mechanisms such as repression and rationalisation. Some forms of coping may actually improve and individual's performance. This often occurs when the arousal from anxiety is great and the individual takes positive action to reduce the unpleasant state. More frequently, however, the methods of coping decrease performance or have a negative effect on the individual. When the consequences of anxiety are positive, the anxiety is called facilitative; when the consequences are negative the anxiety is called debilitative.

Though an extensive foundations of theory and research exists on anxiety, relatively little research studies about specific mathematics anxiety has been conducted. Research on mathematics anxiety provides some general conclusions about the relationship between anxiety and mathematics achievement. Aiken (1970, 1976), Fennema (1977), Fax (1977), Betz (1978), and Holden (1987) had all pointed out that mathematics anxiety contributes to mathematics avoidance and poor mathematics performance.

2.1.1.4 Success Attribution in Mathematics

Success attribution in mathematics refers to students' anticipation about positive or negative consequences as a result of success in mathematics. The way in which a student attributes causation for success and failure is another affective variable prominent in the literature. Mathematics education attribution research uses a formulation of attribution of academic success and failure developed by Weiner (1974). Wiener proposes a two dimensional model with four major causes of success and failure-ability, effort, task difficulty, and luck, organised in 2x2 matrix (see Table 2.1.1).

Table 2.1.1 Attribution of Success and Failure from Wiener

Stability	Locus of control	
	Internal	External
Stable	Ability	Task Difficulty
Unstable	Effort	Luck

The two dimensions are locus of control and stability. Locus of control relates to whether the cause of success or failure is percieved to result from some factor within or outside of the individual; stability is concerned with whether the cause can change for an individual from one time to another. Since ability is the same frame one time to another and is due to a factor within a person, it is categorised as stable and internal. Effort is internal and unstable because the individual has control over effort and may vary the effort expended in different situations. Task difficulty is stable, because a given task doesn't change in difficulty from one situation to another. Task difficulty is also external since a person has no control over it. Luck changes from time to time and is dependent of the individual; therefore, it is classified as unstable and external.

According to the results of the attribution studies done in mathematics, boys attributed their success in mathematics to ability more often than girls, and girls attributed their success to effort more than boys (Wolleat, Pedro, Becker & Fennema, 1980; Parsons, Meece, Adler, & Kaczala, 1982). TIMSS (1997) found that success attribution was important attitudinal factor.

2.1.2 Sex Role

Sex role is an important influence on girls' valuation of mathematics. The value of mathematics to girl can be affected by whether or not she thinks studying mathematics is a sex-role- appropriate activity. If she believes mathematics is inappropriate for girls then her achievement in mathematics could result in a perception that she has not adequately fulfilled her sex role. She might also perceive that teachers and peers have lower expectations for her mathematical success because she is a girl. Another possible outcome is a perception that others see her as somewhat less than feminine when she achieves in mathematics. Sex role is not likely to be as important for males since the prevailing stereotype is that mathematics is a boy dominated and therefore a very appropriate subject for boys study and achievement (Fennema & Leder, 1989).

The effects of stereotyping mathematics as a male domain have been considered in a number of studies with varying results. Fennema and Sherman (1977,1978) found that, on the subscale of the Fennema-Sherman Mathematics Attitude Scales (Fennema & Sherman, 1984) measuring "mathematics as male domain", male and female responses different significantly than did females. Phenomena and Carpenter (1981), Hilton and Burgled (1982), Hanna (1986), Messer (1993) found significant gender differences in mathematics achievement. However, Kavrel and Peterson (1984), Steinback and Gwizdala (1989) Ma (1995), found that there was no gender differences in mathematics achievement.

These mixed results suggest that in spite of the theoretical relevance of this variable to achievement in mathematics, it may not be useful in predicting either participation or achievement in mathematics.

2.1.3 Models in the Mathematics Education

There are three models that guide research studies in the affective domain: Kulm's Model, Fennema and Petersons' Model, Eccles and his collegues Model.

2.1.3.1 Kulm's Model

Kulm (1980) presents a model for the relationship between attitudes and behaviour. The model was developed as a source of hypotheses for research on attitudes toward mathematics (see Figure 2.1.3).

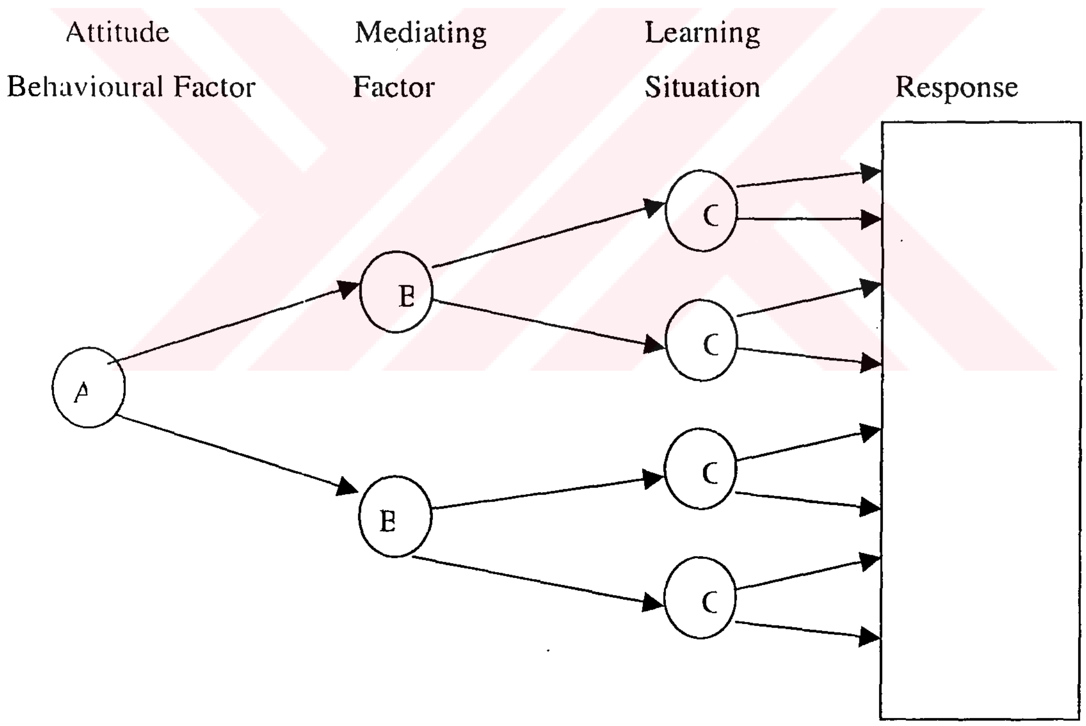


Figure 2.1.3 Kulm's Model "Relationship between Attitudes and Behaviour"

In the model the attitude factor, represented by A, may be either positive or negative. An example of a positive attitude factor is "enjoy mathematics". B represents a mediating factor such as liking the mathematics teacher (a positive factor) or feeling that mathematics is an inappropriate area of study (a negative factor). The learning situation, C, is concerned with factors such as the difficulty of the learning task, the importance of the task, or the length of time needed to complete the learning task. The behavioural response might be spending time on task, being persistent in working on mathematics assignments, or completing difficult assignments.

2.1.3.2 Fennema and Petersons' Model

Fennema and Peterson (1983) developed a model that provides direction for research on gender –related differences in mathematics achievement (see Figure 2.1.4). It is concerned with several affective variables.

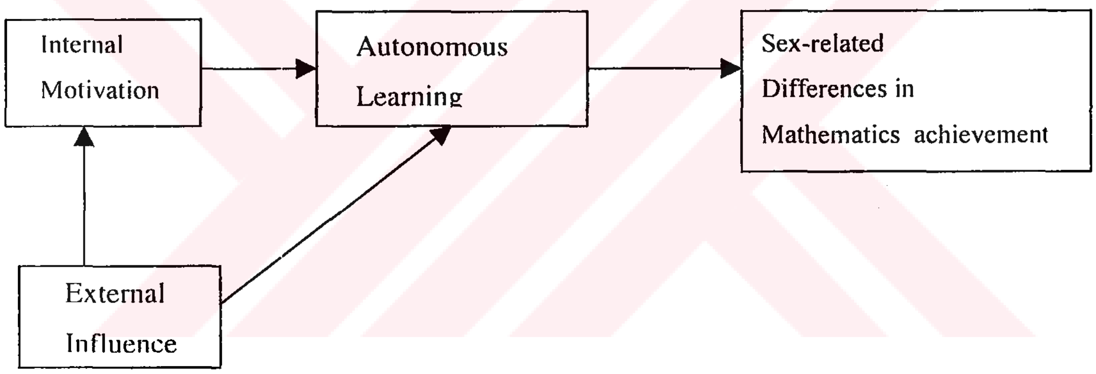


Figure 2.1.4 Autonomous Learning Behaviour Model from Fennema and Peterson

Fennema and Peterson hypothesise that certain behaviours are crucial for success on problem solving tasks in mathematics. In order to solve complex mathematical tasks, student must be able to work independently, must persist, must choose such tasks to work on, and must succeed in solving the tasks, Fennema and Peterson call these behaviours "Autonomous Learning Behaviours" (ALB). The model suggests that ALB are influenced by both internal and external factors, and in turn, differential use of ALB by females and males produces gender –related differences in mathematics achievement (see Figure 2.1.4). In this model, internal motivational beliefs include several interrelated components: confidence in learning mathematics, percieved usefulness of mathematics, pattern of causal attribution for success and failure in mathematics, and perception of how mathematics achievement fits with one's sex role identity. The major external influence discussed by Fennema and Peterson is the mathematics classroom, including all the interactions between teacher and student.

2.1.3.3 Eccles and His Collegaues Model

The model developed by Eccles, Adler, Futterman, Goff, Kaczala, and Meece & Midgley (1983)-view mathematics education from the perspective of achievement motivation and is concerned specifically with students' decisions about enrolling in advanced mathematics courses. This model of achievement integrates a broad range of research on gender-related differences in mathematics and achievement motivation behaviour (see Figure 2.1.4). It builds on the expectancy/value theories of achievement and hypothesises that expectancy for success on a task and the subjective value of the task for the individual are curiciual in students' mathematics course enrollment decisions.

The Eccles model combines confidence, usefulness attribution, anxiety, and several other affective variables to explain enrollment decisions.

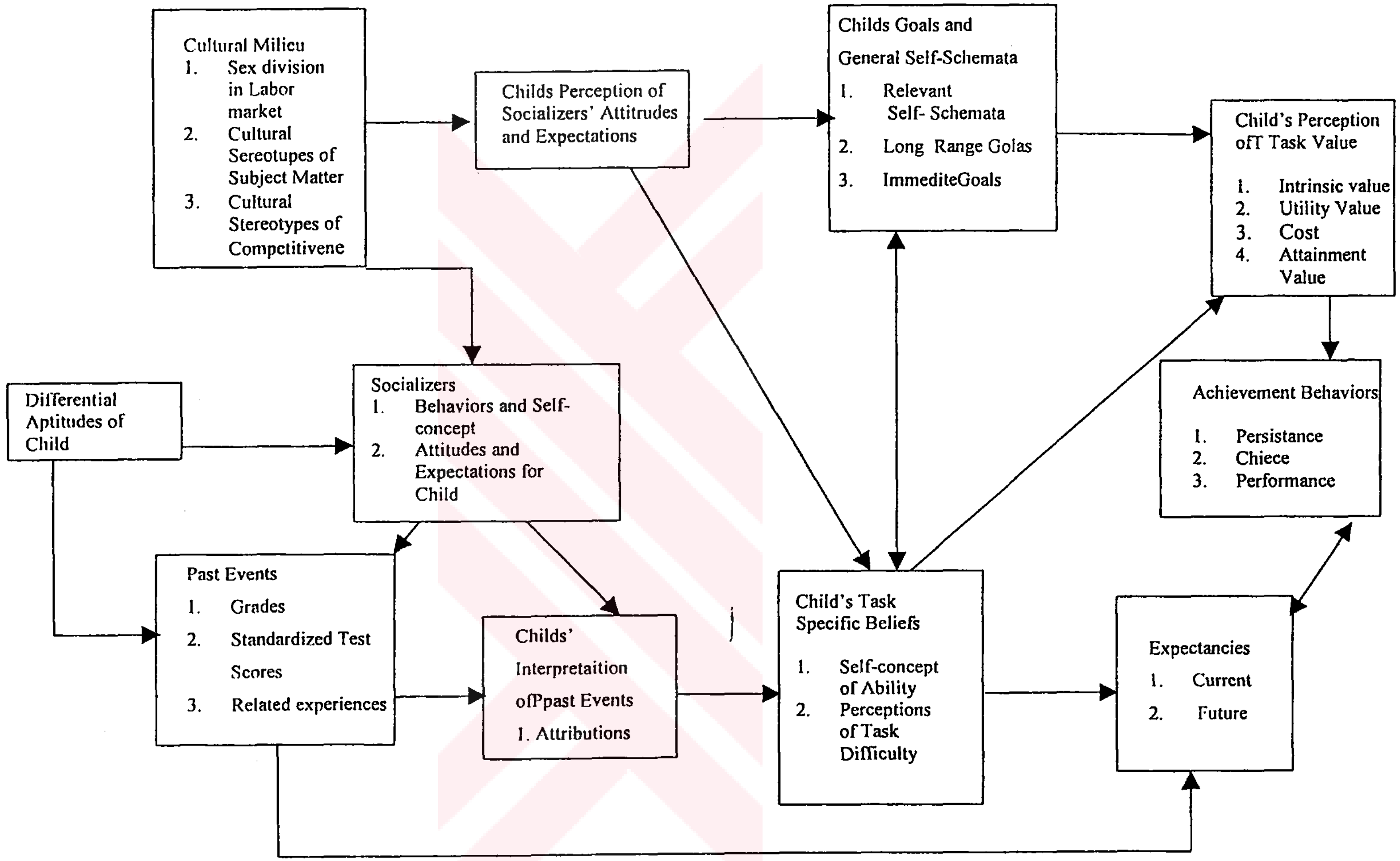


Figure 2.1.5 Achievement Behaviour from Eccless and His

On the basis of relevant literature theory and these three models usefulness of mathematics, importance of mathematics, confidence in learning mathematics, success attribution in mathematics, mathematics anxiety, mathematics as a male domain can be taken as the attitudinal variables.

2.1.4 Teachers' Beliefs and Expectations

2.1.4.1 Teachers' Beliefs

Teachers work and make decisions in a complicated environment. Not only is classroom playing complex, but also the actual interactions between teacher and student demand that teachers make decisions quickly and continually. There is a rapid flow of events that teacher must apprehend and process before deciding how to respond. Teachers need to decide such things as whether the pacing of the lesson is appropriate; whether the activity selected is working to achieve stated goals. What child to call on when a question is asked, how to respond to the answer, how to motivate a certain students. The decisions that teachers make have a strong influence on what their students learn and how they feel about themselves as they learn. (Wolfok, 1993).

Fennema, Carpenter and Peterson (1989) have suggested a model that illustrates how teachers' knowledge and beliefs influence learning, shown in Figure 2.1.6.

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

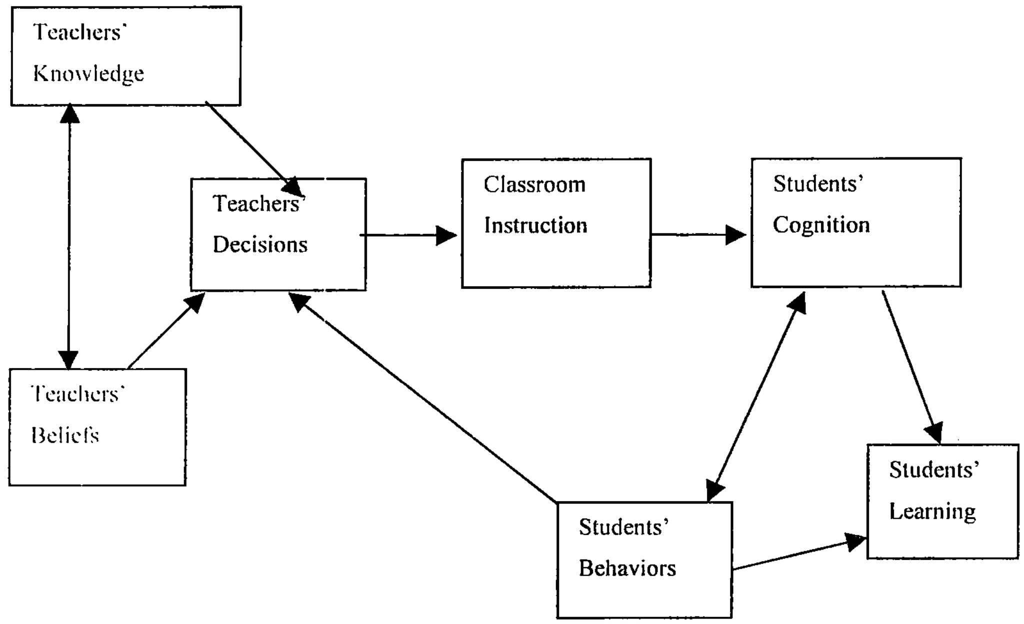


Figure 2.1.6 The Influence of Teachers Knowledge and Beliefs on Students'Learning

In the Bloom's Theory of School Learning the final outcome, students' learning, is directly influenced by children's cognition and behaviours, which in turn are influenced by classroom instruction (see in Figure 2.1.1). Variations in learning and the level of learning of students are determined by the students' learning history and the quality of instruction they receive. As can be seen from the diagram quality of instruction has an observable effect on the learning process and achievement level in learning task or tasks. The interaction between the students and the teacher constitute the quality of instruction (Bloom, 1976).

Since mathematics educators become aware of the significant roles that teachers' beliefs play, the study of beliefs increased in recent years. (Pajores, 1992; Ernest, 1989; Bolin, 1988; Thompson, 1984; Brickhouse, 1990; Schoafeld, 1989; Karp, 1991; Austin and Wodlington, 1992; Carter and Norwood, 1997). They have all pointed out that the form and intensity of the influence of beliefs varied by individual, but teachers' beliefs shape the way in which they teach mathematics. How children perceive mathematics will be based on what teachers do in the classroom. Students' beliefs about learning and beliefs about the nature of the subject matter affect their learning.

2.1.4.2 Teacher Expectations

Teacher expectations may affect students in the following manner. Teachers begin by forming expectations about how individual students will behave or how well each will do in the class. The teachers then treat each student to do well, that student may be given more encouragement or more time to answer a question. Students given more time and more encouragement answer correctly more often. If this pattern is repeated daily for months, the students given more time and encouragement will do better academically and score better on achievement tests. Over time, the students' behaviour moves closer and closer to the kind of performance originally expected by the teachers (Wolfok, 1993)

Braun (1976) has developed a model based on research findings to explain the origins of teacher expectations and the ways in which these expectations are communicated to students and then perpetuated by student behaviour. Figure 2.1.7 show the basic elements of this model.

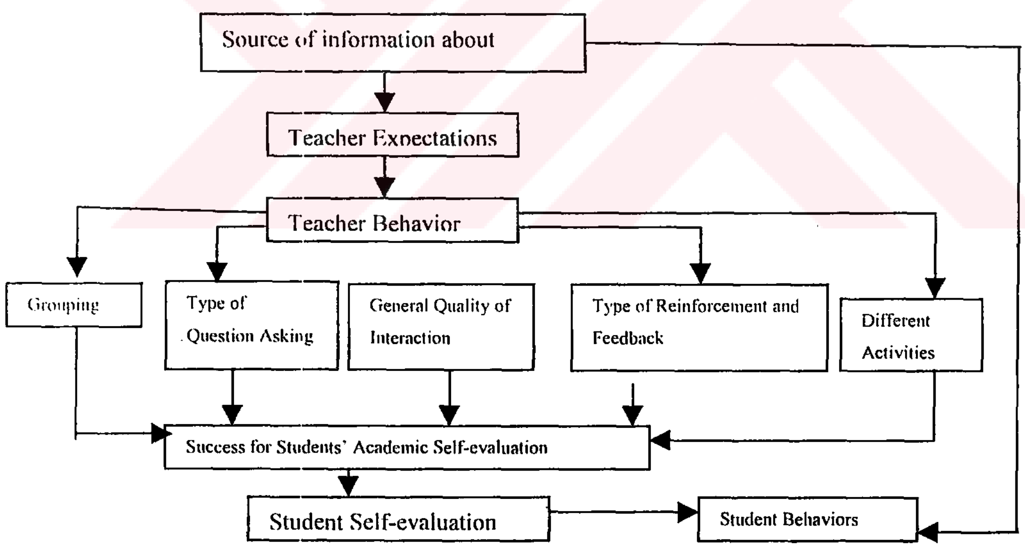


Figure 2.1.7 Teacher Expectations and Changes in Student Behaviour

He lists 10 possible sources of teacher expectations. Intelligence test scores are an obvious source, especially if teachers do not interpret the sources appropriately. Sex also influence teachers; most teachers expect more behaviour problems from boys than from girls. The notes from previous teachers and the medical or psychological reports found in cumulative folders are another obvious source of expectations. Previous achievement, socioeconomic class, and the actual behaviours of the students are also often used as source of information.

With the guide of the Teachers' Beliefs Model, Teacher Expectations Model and the relevant literature teachers' beliefs, their expectations taken as a variable that affect students' attitudes toward mathematics and achievement in mathematics.

2.1.5 Mother and Father

According to the Proffenberger and Norta (1959), parents affect the child's attitudes and performance in three ways: (1) by parental expectations, (2) by parental encouragement, and (3) by parents' own attitudes. Alper (1963) found that student's attitudes were positively correlated with the amount of mathematics education desired by parents for their children. On the other hand, Hill (1967) showed that parental attitudes and expectations for their sons were not significantly related. However, Wang, Wildman and Calhaun (1996) found that variability in student achievement explained by the significant parental variables: mother education level, father education level, mother's expectation from child about learning mathematics, father's expectation from child about learning mathematics.

Ethington (1992) developed models about father and mother influence on males and females diagrammed in Figure 2.1.8 and 2.1.9

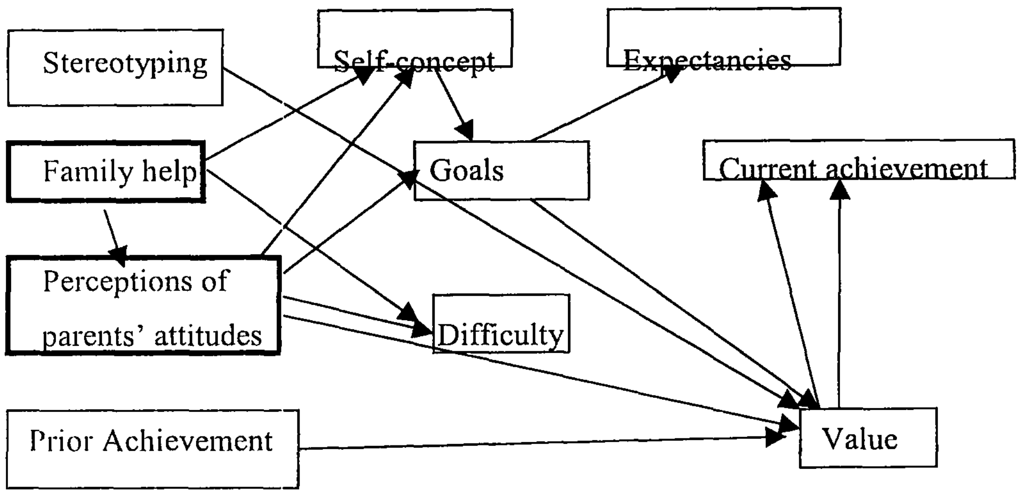


Figure 2.1.8 Parent Influence on Males

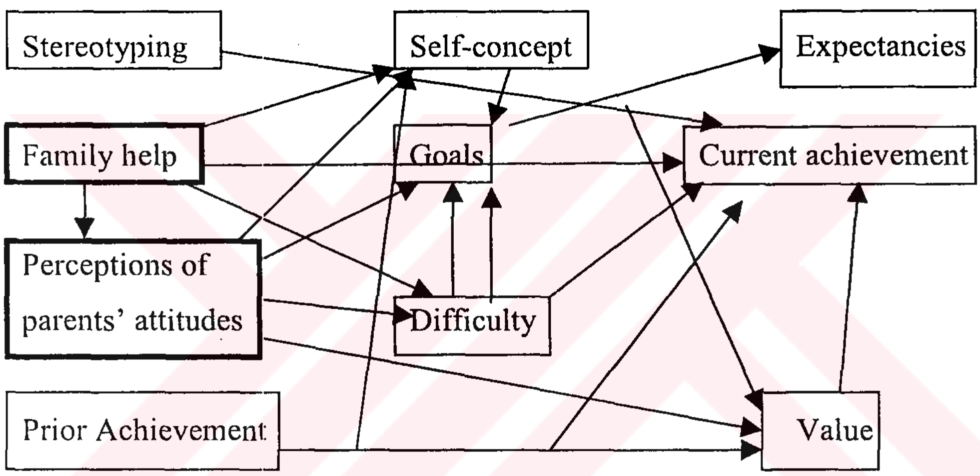


Figure 2.1.9 Parent Influence on Females

According to the models the first block of variables: perception of parents' attitudes, and parental help with the study of mathematics is correlated. The second block of variables represents students' self –concept of their mathematical abilities and their perception of the difficulty of mathematics. Family help, perceptions of parents' attitudes, and prior achievement predominantly influence each of these measures. The next variable represents students' goals related to mathematics. This measure is directly influenced by the self –concept, difficulty, and perceptions of parents' attitudes. The final block of variables contains expectation for success in mathematics and the percieved value of mathematics. Self-concept and perception of difficulty, goals, prior achievement, perception of parents' attitudes are directly influence each of these measures. An additional direct effect on value is expected from goals. The last variable in the model represents the achievement behaviour, which is defined as current achievement in mathematics. Expectations and value directly influence achievement for males, and for females stereotyping, family help and difficulty directly influence achievement, other variables influence indirectly.

2.2. Previous Studies

In light of the prominent role of mathematics among subjects in school, it is not suprising that much educational and psychological research has been devoted to identification of factors that enhance the learning and teaching of mathematics. Extensive research has led to the identification of major groups of factors influencing achievement in mathematics as well as in other subjects: student characteristics (confidence in learning mathematics, mathematics anxiety, success attribution), father and mother quality (parents education levels and students' perception of their expectations, encouragements, interest and confidence in their ability), students perceptions of usefulness and importance of mathematics, teacher quality (students' perceptions of teacher encouragement, interest, confidence in their abilirty and his \ her competency in mathematics). The majority of studies confirm that cognitive student characteristics explain large part of observed variance in achievement and attitudes. (Atkinson, 1964; Carpenter & Corbit, 1980; Khamis & Shotwell, 1980; Corbit, 1984; Reyes, 1984; Jayne, 1990; Vanayan, 1997; TIMSS, 1997).

2.2.1 Relationship between Attitudes toward Mathematics (ATM) and Achievement in Mathematics (AIM)

Over the past 25 years there has been increased concern for the influence of attitudes towards particular subject areas on achievement outcomes in those areas. This attention to the role of attitudes in school learning has been focused particularly on the learning of mathematics in the classroom.

Lots of studies have reported low, but significant positive relationship between students' attitudes toward mathematics and their levels of achievement (Attonen,1969; Tsai&Walberg,1983; Suydam,1984). These results have been found with the samples of primary, secondary and higher education students.

Aiken (1972) investigated attitudes of the 97 boys and 85 girls of the eight grade students toward mathematics. The responses of these students to each item on a ninety item biographical inventory were correlated with total scores on mathematics attitude scale. Correlations were significant. He found that (1) there was a general variable of attitudes toward mathematics includes attitudes toward routine computations, terms, symbols, and word problems; (2) there were sex differences in the direction and degree of the relationship of mathematics attitude to interest in other subjects and to personality characteristics; (3) attitudes toward mathematics was positively correlated with grades in arithmetic and mathematics and (4) attitudes toward mathematics was related to student's perceptions of the attitudes and abilities of their teachers and parents.

In the causal analysis of the attitudes toward mathematics researchers studied on the identification of endogenous variables and on the estimation of strength of their effects on attitudes toward mathematics. The model hypothesised attitude development may be influenced by a number of factors operating inside and outside of the school (see in Figure 2.2.1). Although the model recognised that exogenous factors (originating outside school) such as the student's gender, social class, and scholastic aptitude may contribute to attitude formation these factors were not included in the model for two reasons. First, these exogenous variables resided outside of the educator's sphere of immediate influence in school. Secondly, an earlier analysis of data on attitudes toward mathematics suggested that these exogenous variables have a limited relationship to attitude (Haladyana & Shaughnessy, & Shaughnessy 1982). The model therefore concentrated on the effect of endogenous variables within the school that were seen as alterable. The model posited that the development of attitude toward mathematics was likely to be influenced by the teacher and the learning environment.

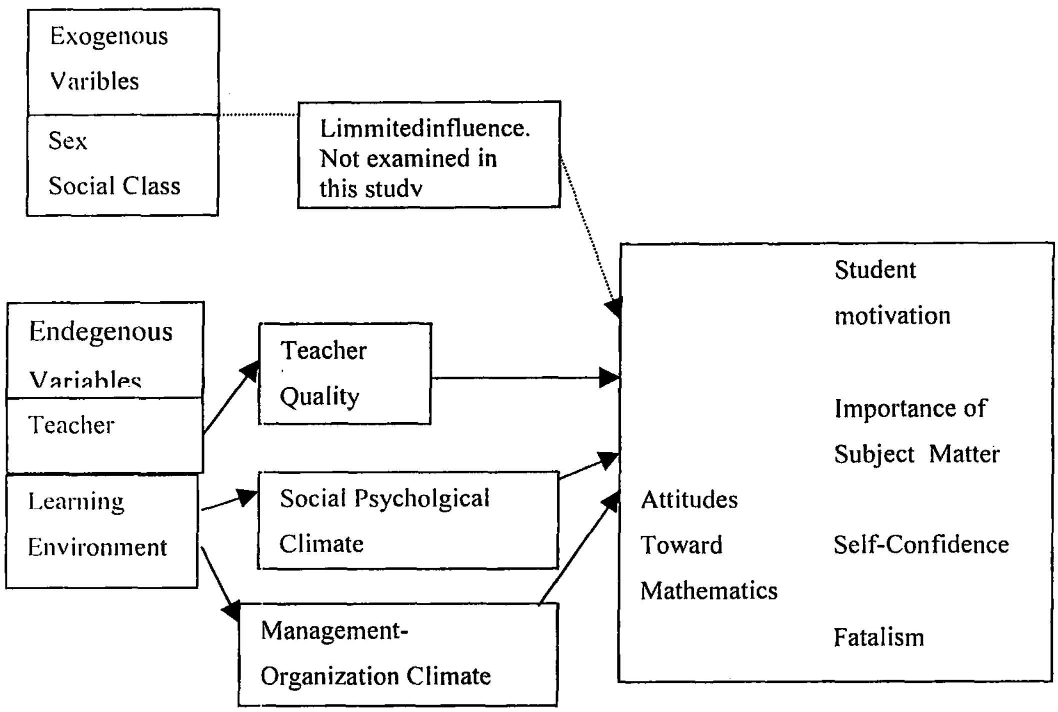


Figure 2.2.1 Hypothesised Model of Haladyana, Shaughnessy, and Shaughnessy

Five dimensions of the model that were (1) student motivation, (2) teacher quality, (3) social-psychological class climate, (4) management organisation class climate, (5) attitudes toward mathematics. Attitudes toward mathematics were examined in the relationship with student motivation, teacher-quality, the social-psychological class climate, and management-organisation class climate. To investigate the validity of the model and to explain causal determinants of attitudes toward mathematics the technique of path analysis was used. They found strong associations between teacher quality measures and both attitudes toward mathematics and student motivation (Haladyana, Shaughnessy, Micheal , 1983).

In the Third International Mathematics and Science Study (TIMSS, 1997) researchers investigated influencing factors on achievement in mathematics in grade 8 among nine European countries. The nine Education system were: Belgium Flemish, Belgium French, Czech Republics, Denmark, England, Lithvania, Norway, Sweden and Netherlands. From nine countries totally 19 671 eight grade students included in the study. As seen in Figure 2.2.2 included influencing factors were homework, teaching style, school climate, student's gender, maternal expectations, friends' expectations, success attribution, instructional formats, mathematics lesson climate, attitude towards mathematics, home educational backgrounds, teacher's expectation, class size, effective learning time, assessment, students' attitudes toward mathematics, and out of school activities. The model with the selected variables explored by means of path analysis. On the basis of path analysis outcomes they found that a few factors, seem to be important to explain variances in mathematics achievement: (1) home educational background (positive relation with mathematics), (2) out of school activities (negative relation with mathematics), (3) attitudes toward mathematics (positive relation with mathematics) (TIMSS, 1997).

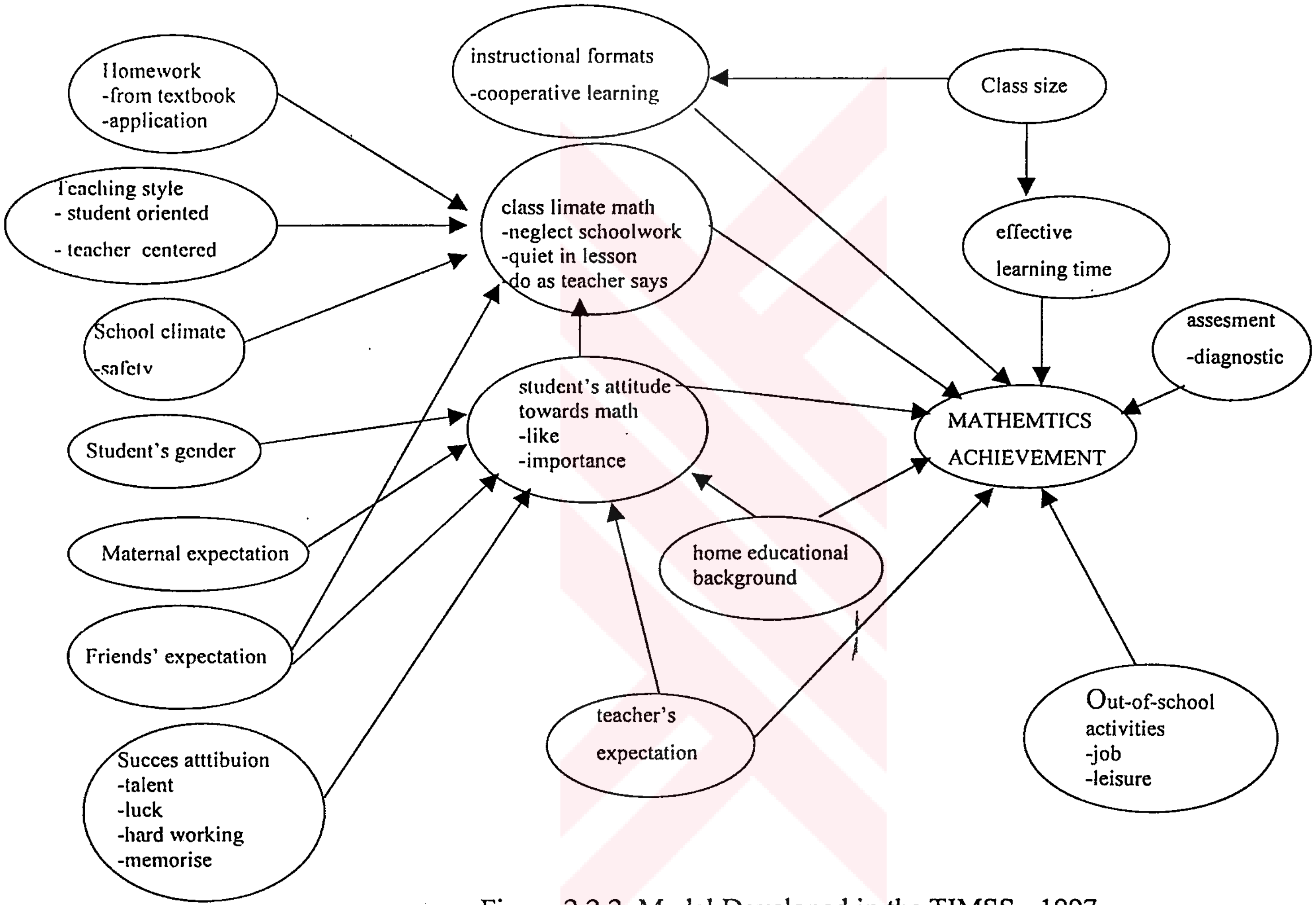


Figure 2.2.2 Model Developed in the TIMSS - 1997

Welch, Anderson and Harris (1982) tried to determine the proportion of variance in mathematics achievement attributable to differences in the number of semesters of mathematics courses after taking into account the influence due to various background variables. Data had drawn from the 1977-1978 National Assessment of Educational Progress in Mathematics. Sample of the study was 2216 17 year old students. The multiple regression analysis performed. It was found that background variables (welfare, profession status, parent education) accounted for 25 percent of the variance while exposing mathematics courses explained an additional 34 percent of the variance. It was also found that there were strong relationships between nonschool background variables and mathematics achievement.

Tsai and Waberg (1983) investigated the dependence of mathematics achievement and attitudes toward mathematics on each other and other factors. Achievement test scores and ratings of 23 68 13 – year-old students who participated in 1977-78 National Assessment of Educational Progress were analysed. Frequency distribution for each independent variable mean, and standard deviations were calculated. They found that achievement was significantly associated with attitudes, gender, ethnicity, father's and mother's education, verbal opportunities in home and frequency of mathematical practices, when variables were statistically controlled for one another. Constructive mathematics attitudes were associated with achievement and some factors except parent education. About 32 percent of the achievement variance could be accounted by the factors.

Similarly, Cheung (1988) examined the relationship between mathematics achievement and attitudes toward mathematics in junior secondary schools in Hon Kong. Data were obtained from 130 grade 7 classes (age = 13). Within each class all students were tested. Achievement and attitudinal data were obtained for 5644 students. Mathematics achievement within the intentionally defined curriculum was measured using specifically designed tests by Second International Mathematics Study project committee. Ten, 5 point Likert scales with 5 indication the most positive views towards mathematics were used to elicit students attitudes and perceptions on percieved home supports, percieved home process, mathematics importance, mathematics easy, mathematics like, mathematics create, mathematics rules, mathematics and myself, mathematics and society and sex-stereotyping. In order to investigate the nature and the degree of relationship between mathematics achievement and various dimensions of attitudes toward mathematics, scatter diagrams were plotted and pearson correlation calculated. The results indicated that correlation between the attitudes dimensions and mathematics achievement were positive, showing that the more positive the students' attitudes toward mathematics, the higher achievement in mathematics. The greatest correlation was associated with mathematics and myself, which is a measure of the students' own estimation of their ability in doing mathematics; it was attained value of 0.42. Another two larger correlations were associated with mathematics and society and mathematics create (0.37 and 0.31), which measured the students' perception of the usefulness of mathematics in society and of mathematics as creative subjects. The other dimensions of attitudes toward mathematics were associated with lower correlation coefficients. He also found that relationship of mathematics achievement and attitudes toward mathematics learning is reciprocal in nature. Thus, he pointed out that it was not appropriate to depict only a direct causal link from attitude to achievement and not indirectly or other way around.

Reynolds and Walberg (1989) developed a structural model of mathematics achievement and attitude. Data collected from 3 116 eight grade public school students (see Figure 2.2.3) . The model developed by the Reynolds and Walberg can be seen in Figure 2.2.3. As can be seen from the figure 2.2.3 included variables in the model were motivation, mass media, instructional time, percieved quality of instruction, home environment, percieved peer environment, class environment, grade 7 mathematics achievement, grade 7 mathematics attitude, grade 8 mathematics achievement and grade 8 mathematics attitude.

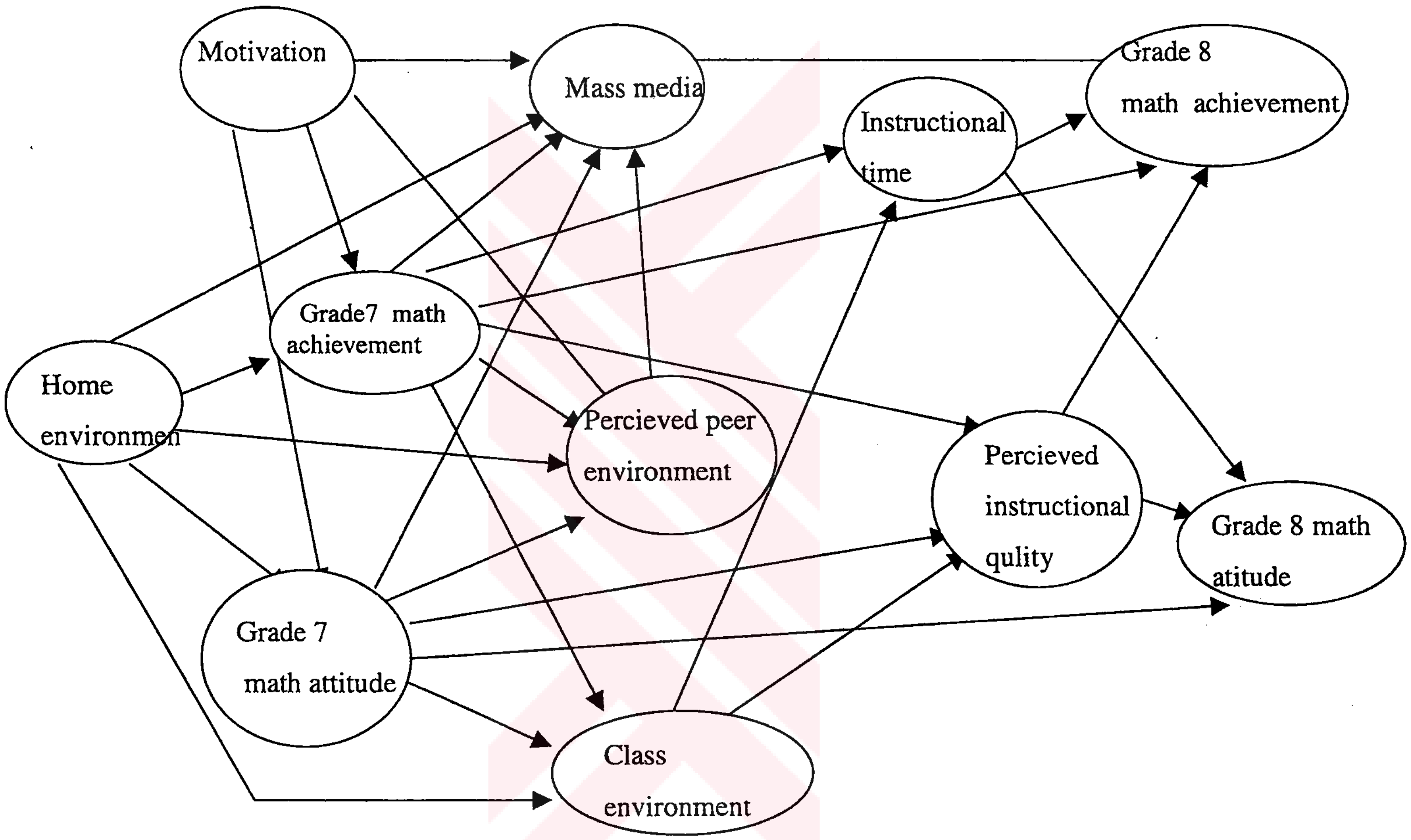


Figure 2.2.3 Theoretical Model Developed by Reynolds and Walberg

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

The measurement and structural models estimated by LISREL 7. Results revealed that the productivity factors operate in complex network effects that have not been apparent in previous studies. Results of the study indicated that prior achievement and home environment influenced subsequent achievement most powerfully; motivation, exposure to extramural reading media, peers involvement, and instructional exposure also had significant influences on achievement. It was found that previous attitude had the most powerful influence on subsequent attitude, although the direct effects of instructional quality and indirect effects of motivation and home environment were also notable. It was also found that teacher use of instructional time and instructional practices were significantly effect mathematics attitudes.

Ma and Kishor (1997) investigated the relationship between attitudes toward mathematics (ATM) and achievement in mathematics (AIM) at elementary and secondary levels. To assess the magnitude of this relationship, they conducted a meta-analysis study to integrate and summarise the findings of the 113 studies. The statistical results of these studies were transformed into a common effect size measure, correlation coefficient. It was found that the relationship dependent on a number of variables: grade, ethnic background, sample selection, sample size, and date of publication. This meta-analysis revealed four results; (i) overall mean effect size was 0.12 for the general ATM-AIM relationship, which along with the causal relationship between ATM and AIM, doesn't have meaningful implications for educational practices; (ii) grade, ethnicity, sample selection, sample size and date of publication all had reliable effects on the ATM-AIM relationship; (iii) gender did not have a reliable effect on the ATM-AIM relationship; and (iv) there was no reliable evidence of interaction effects among gender, grade, and ethnicity on the ATM-AIM relationship. However, all of the causal studies in this meta-analysis specified a unilateral relationship between ATM-AIM, disregarding the fact that a unilateral relationship can not capture the interactive characteristics of ATM and AIM. So, researchers suggested that to investigate the bilateral relationship between ATM and AIM use advanced statistical techniques such as structural equation modelling.

Furthermore, Ma (1997) studied on the reciprocal relationship between ATM and AIM by using structural equation modelling. He administered two mathematics achievement tests and one mathematics attitude scale to obtain data from high school senior from Dominican Republic. There were 15 sections in attitude scale. Each section included three items that measured how important, difficult, enjoyable students felt about mathematical areas (arithmetic,algebra, geometry, trigonometry).

The model developed by Ma (1997) (see in Figure 2.2.4) structure contained three blocks, beginning with father's education level (FAED), mother's education level (MOED), and student's sex (SEX), followed by student's AIM measures of algebra, geometry, or trigonometry indicated as important (IM), difficult (DI), and enjoyable (EN) and ending with students' AIM. Single arrows represented direct causal effects; the arrows pointed from the cause to effect. Double arrows represented general correlations between two variables, assuming no causal implications.

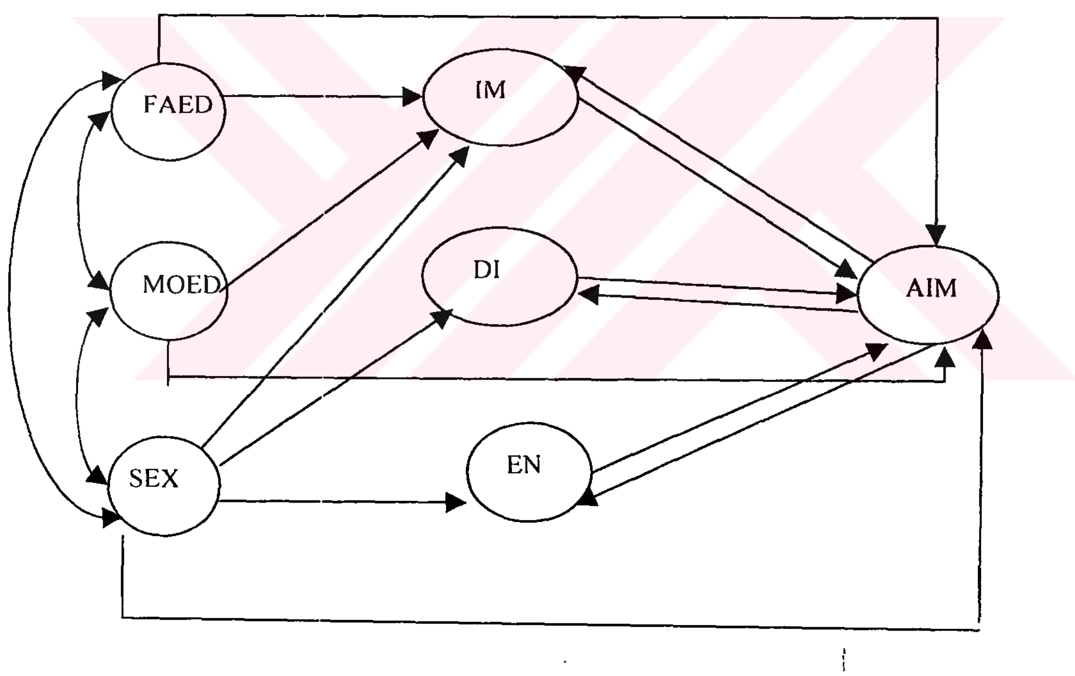


Figure 2.2.4 The Structural Model of Reciprocal Relationship between ATM and AIM Developed by Ma.

To obtain model and to test the goodness of the model-data fit Linear Structural Relations (LISREL) was used. Major findings of the study can be stated as (i) A reciprocal relationship existed between every attitudinal measure and mathematics achievement; (ii) The feeling of enjoyment, not the feeling of difficulty directly affected mathematics achievement; (iii) The feeling of difficulty functioned via the feeling of enjoyment to affect mathematics achievement; (iv) The perception of mathematics as important was independent of other attitudinal measures.

Consequently, these findings suggested that reciprocal or interactive nature between attitudes toward mathematics and achievement in mathematics could substantially modify their causal relationship. In addition, it is likely that a student who feels very positive about mathematics will achieve at a higher level than a student who has a negative attitudes toward mathematics, It is also likely that a higher achiever will enjoy mathematics more than a student who does poorly in mathematics.

2.2.2 Relationships between Importance of Mathematics and that of ATM and AIM ; relationships between Usefulness of mathematics and that of ATM and AIM

Over the years, numerous studies have been conducted to examine students' beliefs and attitudes toward mathematics. In much of these research studies assumption is that positive affect might lead to positive achievement behaviour. While some psychologists emphasise the role of ability related self-perceptions in motivating achievement behaviour, other attribute equal importance to subjective task values in predicting behaviour. These subjective task values are defined in terms of interest in and enjoyment of the task, percieved importance of being good at the task, and percieved usefulness of the task.

In her study, Vanayan (1997) tried to describe beliefs and attitudes toward mathematics among third-and fifth grade students. A total of 1344 (679 girls, 665 boys) grade three, and 1412 (745 girls, 667 boys) grade five students participated. Students responded survey containing 22 items that addressed students' attitudes and perceptions regarding mathematics. Other information that was collected concerned demographics, classroom practices, parental involvement, and activities at home, all of which were of interest to educators at the school district. Student responses to survey items were analysed with respect to gender and grade level by using Chisquare tests. She found that no gender or grade differences when students were asked whether they like mathematics. More boys than girls reported feeling competent in mathematics. In addition no gender differences found in students' perceptions concerning relevance of mathematics. Also no gender or grade differences in students' beliefs regarding the process of learning mathematics were found.

Similarly, Khamis and Shothwel (1980) found that no significant gender differences in the beliefs about mathematics itself, but the reason given by girl and boy students for getting good and bad grades follow the generally excepted view that boys attribute their good results to being good at mathematics as well as working hard. In addition, there was a general tendency to see mathematics as mostly facts, procedures that have to be memorised. In the study 1 149 boy, 990 girl totally 2129 secondary school students participated. Information was sought on students' beliefs concerning (a) their mathematical success or failure, (b) the nature of mathematics learned, (c) the learning of mathematics in relation to other subject, (d) learning geometry and (e) perceptions of parental expectations.

Furthermore, Jayne (1996) investigated high school students' beliefs about mathematics and science during a four week summer residential mathematics and science program. Beliefs about mathematics and scientific truths, the value and importance of mathematics and science inquiry, gender equity and ability with respect to pursuit of mathematics were examined. Twenty high school students in the summer between their sophomore and junior years participated in a four week residential program. Students completed a mathematics and science beliefs instrument. Determining items upon which there was agreement, disagreement, and mixed and uncertain responses tabulated results of beliefs inventory. She found that students were all agree that mathematical and scientific inquiry were equally accessible to either gender. And also they were all agree that knowledge of mathematics and science profits all students and mathematics and science develops good reasoning ability.

Mathematics, for a number of reasons, is sometimes viewed as an unpopular subject, one that provokes strong negative responses among students. Carpenter and Corbit (1980) studied on students' perceptions of mathematics. Data had drawn from the attitude exercises and other questions of about students' perceptions of mathematics that were administered during the 1977-78 mathematics assessment. These exercises were divided into categories: mathematics in school, mathematics and oneself, mathematics and society. Mathematics in school category contained items that ascertained students' feelings about (i) mathematics as a school subject in relationship to other school subjects, (ii) particular items of mathematics content and (iii) specific classroom activities. According to the results obtained on this portion of the exercises they found that mathematics was liked by younger students and viewed as easy by majority of them. In the mathematics and oneself category they found that 95 percent of students percieved their parents wanted them to do well in mathematics. The exercises mathematics and society category assessed student's perceptions of the usefulness of mathematics to themselves as individuals and broader concerns of society. They found for a large majority of students math was not seen as more for boys than girls or vice-versa and math was important to get good job.

Focus of the Corbit's (1984) investigation was students' liking mathematics and how important they percieved the subject to be. The results reported by him deal with students' beliefs and feelings about mathematics as school subject, especially when viewed in relationship to other school subjects. He found that subjects were ranked in terms of decreasing importance, as follows: Mathematics, English, Social Studies, Science and Physical Education. The opinion that mathematics was an important subject to study in school was substained by results from the interview. Ninety percent of interviews answered affirmatively to the question, "Do you know any body who would say that math is his or her favourite subject?" (p.17). When asked for explanations about why individuals might like the subjects, she found that most explanations felt into two categories: (1) people liked mathematics if they were good at it and (2) the mathematics teacher influenced whether or not mathematics was liked.

Shortly, we can say that student clearly regard mathematics as a useful and important discipline to study. Older students percieved a link between mathematics and future employment or higher education. Various studies have revealed that students regarded mathematics as being of equal or even greater importance compared to other subjects such as English, Social Studies and Science (e.g., Corbit,1984; Carpenter, 1980). Students recognised the every day usefulness of mathematics, its importance to society and could relate mathematical topics to everyday lives. Students who received higher scores on tests of mathematics achievement viewed mathematics as more useful than the lower-achieving students (Fennema & Sherman 1977 and 1978).

2.2.3 Relationship between Affective Variables and that of ATM and AIM

At elementary and junior-high levels, attitude toward mathematics and achievement in mathematics are significantly related to a number of affective variables indicative of good adjustment (Aiken,1972; Reyes, 1984). Some of the affective variables related to mathematics attitude and achievement are confidence in learning mathematics, success attribution, fear of failure in mathematics, and gender.

2.2.3.1 Confidence in Learning Mathematics

Confidence is one of the most important affective variables in education. Its relationship with mathematics achievement and course election has been studied, particularly in the context of understanding gender-related differences in mathematics (Reyes, 1984). Confidence in learning mathematics was studied in the National Longitudinal Study of Mathematical Abilities (NLSMA) (Crosswhite,1972). Crosswhite reported correlations between confidence and mathematics achievement scores ranging from 0.19 to 0.37. Similary, Fennema and Sherman (1977,1978) studied the relationship between confidence and mathematics achievement for student in grades 6-12. They found positive correlations of approximately 0.40 between mathematics achievement and confidence as measured by the Fennema-Sherman Confidence Scale. Moreover, Marsh, Relich and Simith (1983) demonstrated that mathematics achievement was most highly correlated with mathematics self-concept (r=0.55), less correlated with self-concepts in other academic areas (reading r=0.21) all school subject (r=0.43), and uncorrelated with self-concepts in academic areas.

In the study of Mars, Parker and Barnes (1985), self-description questionnaire (SDQ) II was administered to 901 students (11 to 18 years old) in grades 7 through 12 who attended one public co-educational high school. All of the SDQ II scales were significantly correlated with mathematics achievement, gender and age, though the effects of gender and age were small and independent of each other. Mathematics achievement was most highly correlated with math self-concept. They found statistically significant gender differences in math-self concept in favour of boys.

However, Bulut (1988) didn't find statistically significant relationship between mathematics self-concept and mathematics achievement of mathematics prospective teachers. In addition there was no statistically significant relationship between math self-concept and gender.

2.2.3.2 Success Attribution in Mathematics

Mathematics education research concerning attribution deals with students' perceptions of the causes of student success or failure on mathematics tasks (Weiner, 1974).

In the Third International Mathematics and Science Study (TIMSS) (1997) success attribution mathematics was taken as a latent variable and in the path model it affected student's attitudes toward mathematics. To measure success attribution mathematics, students were asked about four manifest variables to what extent think it is needed to do well in mathematics: a lot of talent, to have good luck, to undertake lots of work, hard studying at home and to memorise the text books. They found that the opinion of students of the importance of hard working to do well in mathematics was positively correlated with attitudes.

Wolleat, Pedro, Becker and Fennema (1980) studied 647 girl and 577 boy students in 10 midwestern high schools. They were administered both Mathematics Attribution Scale (MAS) and standardised achievement test for algebra and geometry. They found that boys attributed their success in mathematics to ability more often than girls did did and girls attributed their success to effort more than boys did. Also, girls more than boys attributed their failure in mathematics to lack of ability and to the difficulty of the task. Multiple regression analyses were performed to examine among gender, achievement and attribution. They found that in analyses of the amount of variance on the MAS subscales accounted for gender, achievement and gender x achievement, all of the regression coefficients were statistically significant ($p < 0.05$). They concluded that girls were likely than boys to attribute success to effort. High achiever girls made more effort attributions for success than low achiever girls. High achiever boys made fewer success attributions to effort than their low achieving counterparts.

2.2.3.3 Mathematics Anxiety

Fear of failure or lack of confidence, as well as some contextual factors inhibit understanding and enjoyment in mathematics (Byrd, 1982; Reyes, 1984). The way in which students perceive mathematics and learning mathematics has important impact on their success in the subject.

Many students faced with frustration, conflict and limitation to feel competent in mathematics. One concept, which increasingly explains poor mathematics performance, is that of mathematics-anxiety. After the recognition of the term mathemophobia by sister May Fides in 1954, the topic of math anxiety come into consideration in psychology and research. Psychologist usually link poor mathematics achievement, discomfort with mathematics, negative attitudes toward mathematics, avoidance of mathematics tasks with the construct of anxiety toward mathematics.

Drager and Aiken (1957) surveyed the incidence of "number anxiety" in a college population. They found that number anxiety and achievement in mathematics was negatively correlated.

Although the disruptive effects of anxiety are usually emphasised, anxiety may have either negative or a positive effect on performance depending on its intensity, the task and the individual (Aiken, 1970).

Alpert, Stellwagan and Becker (1963) constructed separate inventories of facilitating anxiety and debilitating anxiety. Both inventories were significantly correlated with achievement, but in opposite directions: facilitating anxiety was positively correlated, and debilitating anxiety negatively correlated with achievement in seventh grade mathematics.

Degnan (1967) compared the attitudes and general anxiety levels of 22 eight-grade students designated as low achievers in mathematics. He found that the achievers were generally more anxious than the underachievers, the achievers had more positive attitudes toward mathematics. Also, when the students were asked to list their major subjects in order of preference, the achievers gave mathematics a significantly higher ranking than the underachievers.

Carpenter (1980) reported that 21 percent of the nine years olds they studied claimed that doing mathematics makes them nervous.

Most of the researchers reported that a general agreement that levels of math-anxiety negatively affected academic performance in mathematics. Aiken (1970,1976), Fennema (1977), Fox (1977), and Betz (1978), have all pointed out that mathematics anxiety contributes to mathematics avoidance and poor mathematics performance has been particularly emphasised for girls. But in the millieu of 70's and 80's with the changing role of girls in the society, mathematics anxiety is slowly moving in the direction of becoming equal opportunity debility.

Holden (1987) studied on 7000 American students in years 9 to 11 and he found that mathematics anxiety for females had declined over previous years.

2.2.4 Relationship between Gender, ATM and AIM

A factor, which could discourage girls from pushing the study of mathematics as a career, is the general view held by society that mathematics is a male domain. Relevant research on this topic has lead to conflicting results. Boys have been found to perform better in some studies and girls in others (Kaczala, 1981, Gwizdala & Steinback, 1988; Fennema & Carpenter, 1981; Hanna, 1986) . The research has indicated that differences are minimal at the primary school level, and more evidence was found that gender differences in mathematical performance begin to emerge at the junior high level. The junior high school years are important to study because gender-role identification becomes more prominent, and curicial educational choices are made at this stage (Aiken, 1976, 1977).

Fennema and Carpenter (1981) found that on a notion wide basis, there was slight difference between girls and boys in overall mathematics achievement at ages 9 and 13, at age 17. However, girls were not achieving at the same level in mathematics, as were boys. Even when girls and boys enrolled in the same mathematics courses boys' performance was higher than that of girls and differences were greatest on the more complex tasks.

Hilton and Berglund (1982) found that no sex differences in mathematics achievement at grade 5 level. Whereas, at subsequent grade levels (grades 7,9 and 11) boys had higher scores than girls and the differences between the genders increased with age. Furthermore, the growing differences in mathematics achievement between the boys and girls affected the differences in interest. As boys' interested in mathematics increased relative to the girls their achievement in mathematics increased relative to that of girls.

The relationships among plans for electing mathematics courses causal attributions and several attitudes that appear to be salient in influencing both girls and boys to elect mathematics courses.

Pedro, Wolleat, Fennema and Becker (1984) studied on the identification of important variables that related to the election of mathematics courses for each gender enrolled in algebra and for each gender in geometry classes. Subjects of the study were 633 girl, 572 boy students enrolled in nine high schools. Of the total set of variables investigated in the study, they found that only a small subset of attitudes and attributions helpful in explaining the variation in high school mathematics plans when achievement controlled. Usefulness appeared to the variable having the strongest relationship with the mathematics plans of both genders.

In her study Hanna (1986) was found that the mean percent of the correct responses for two of the five topics (geometry and measurement) was slightly higher for boys than for girls. These differences though not large, were statistically significant at the 0.01 level. Also, all differences between boys and girls in omitted responses were significant at the 0.01 level. The girls had much higher omission rates on all topics. On the average, the omission ratio of boys to girls was 2:3. Three thousand five hundred and twenty three eight grade students were participated in her study.

Messer (1993) found that there were still significant gender differences in many areas, such as: interest in mathematics, importance of high attainment in mathematics, willingness to consider entering a career involving mathematics and mathematical activities and themes from the real world which interest the pupils. 749 secondary school students aged 14-19 participated in the study.

On the other hand, Hall and Hoff (1988) did not found significant gender differences or gender by grade level differences while investigating whether gender differences began to emerge among grade two, four and six or not. Subjects were the students at grade levels two, four and six.

Moreover, Kavrell and Peterson (1984) analysed longitudinal data over early adolescence to examine the nature of changes in gender role identity, attitudes toward mathematics and achievement in the major courses. 149 young people participated. They did not find any explanation of gender differences.

Ma (1995) found that no significant interaction effects between gender and education system and no significant gender differences in algebra. There were two populations in the study. A population A consisted of 13 years olds and population B consisted of high school students. In each population there were 60 boys and 60 girls.

Additionally, gender differences in mathematics attitudes of secondary school students, and differences in mathematics attitudes of girl students before and after the merger were investigated in the study of Steinback and Gwizdala (1995). Total 697, 374 boy and 323 girl (173 of the girls took part in both years of the study) participated in the study. The paired analysis of girl participants in both years of the study showed that the inclusion of boys in the school, and the mathematics classroom in particular, for the most part did not change girl students' attitudes after only one year. They found that their attitudes toward both mathematics and their own performance in mathematics remained generally positive. They pointed out that both the girls and the boys reported that the teacher considered the boys smarter and the boys themselves perceive that boys are smarter.

Consequently, studies that have been carried out into gender differences in mathematical performance and attitudes toward mathematics arrive at diverse conclusions ranging from lack of gender differences to significant gender differences.

2.2.5 Relationship between Teacher - ATM and Teacher - AIM

Although teachers' knowledge of mathematics and how to teach it is important, their beliefs about mathematics teaching and mathematics itself can have equal impact on students.

Teacher's attitudes and effectiveness in mathematics are viewed as being prime determiners of students' attitudes and performance (Aiken, 1972). Teachers' beliefs about mathematics and attitudes toward mathematics do influence how they teach mathematics (Braun, 1976; Fennema and Peterson, 1989).

Garner (1963) administered an inventory concerning attitudes toward algebra to 45 first –year algebra teachers and their 1163 pupils in Texas school system at the beginning and end of the school year. He found statistically significant relationships between (i) teacher's background in mathematics and students' achievement in algebra; (ii) teacher's attitudes toward algebra and students' attitudes; (iii) teacher's and students' judgements concerning the practical value of algebra.

Torrance (1966) studied 127 sixth-through twelfth grade mathematics teachers who participated in an experimental program to evaluate SIMS 6 instructional materials. He found that teacher effectiveness had a positive effect on student attitudes toward teachers, methods, and overall school climate.

Fennema, Peterson, Carpenter and Lubinski (1990) gathered information about teachers' attributions and beliefs in relation to gender and mathematics. The subjects for the study were 38 first grade female teachers in 24 schools in the U.S. These 38 teachers thought 368 first grade boys and 314 first grade girls. T-test was used to analyse data. They found that there were gender differences in mathematics achievement in these grade 1 students. Teachers' choices of most and least successful students were compared to mathematics test scores of their students. Teachers were most inaccurate when selecting most successes and failures to ability and girls' successes and failures to effort. Teachers' attributions and beliefs about first grade boys and girls in mathematics were different.

Karp (1991) investigated the relationship of the teaching behaviours and instructional methods of elementary school teachers to the teachers' attitudes toward mathematics. Sample consisted two classrooms from both the fourth and sixth grades, totally 33 teachers included. He found that the daily experiences of students in mathematics classes of teachers with positive attitudes were substantially different from those of students in classrooms of teachers with negative attitudes. Teachers with negative attitudes toward mathematics teaching methods used that fostered dependency whereas teachers with positive attitudes were found to encourage student initiative and independence.

Austin and Wodlington (1992) investigated the effects of mathematics beliefs on mathematics anxiety and mathematics self-concept of college students. Fifty pre-service and 15 in-service teachers participated in the study. All subjects were given that Mathematics Anxiety Rating Scale (MARS), The Kulm Mathematics Self-Concept Test, and Mathematics Belief Survey Instrument (MBSI). Subjects were divided into groups based on whether they agreed or disagreed on each of the 13 MBSI stems. By the use of an analysis of variance they found that mathematics beliefs had no significant effect on mathematics anxiety and a significant effect on mathematics self-concept.

Cater and Norwood (1997) studied on the relationship between teacher beliefs about learning and teaching of mathematics and their respective students' beliefs about mathematics. 7 teachers and 157 students who were thought by them participated in the study. To analyse data means and standard deviations were calculated. They found that what the teachers did in the classroom influenced his/her beliefs about mathematics. In other words, What teachers believed about mathematics and teaching of mathematics influenced what they did in the classroom and that their belief might be translated into students' beliefs.

While the form and intensity of the influence of beliefs varied by individual, it could be concluded that teachers' beliefs shape the way in which they teach mathematics. How children perceive mathematics will be based on what they do in the classroom. Students' beliefs about learning and beliefs about the nature of the subject matter affect their learning.

2.2.6 Relationship between Mother– ATM, Father – ATM and Mother – AIM and Father–AIM

Since a child's first experience with arithmetic usually occur in connection with his parents, one might expect that parents' attitudes and abilities in mathematics would affect those of their children. The influence of the parents is demonstrated by the fact that pupils' attitudes and achievement in mathematics are positively related to the attitudes of their parents (Aiken, 1972).

According to Proffenberger and Norta (1959), parents affect the child's attitude and performance in three ways: (1) by parental expectations of child's achievement; (2) by parental encouragement; and (3) by parents' own attitudes toward mathematics.

Alper (1963) developed a parental interview and questionnaire to determine the extent to which parental attitudes and values were consistent with those of the

School Mathematics Study Group, and how much they affected the attitudes of their seventh grade children toward mathematics. He found that students' attitudes, for both boys and girls were positively correlated with the amount of mathematics education desired by parents for their children.

Hill (1967) interviewed the father and mother of 35 upper-middle class boys and administered a questionnaire concerned with attitudes toward mathematics to their sons. He found that a greater similarity between the attitudes of mothers and sons was related to maternal warmth, use of psychological control techniques, low parental participation in child rearing. Parental attitudes and expectations for their sons were not significantly related, but sons did show greater accordance with the expectations of their fathers than with those of mothers. The variables of father warmth and degree of participation in child rearing were positively related to the degree of son's accordance with father's expectations. Fathers who had greater expectations of masculine behaviour on the part of their sons and who viewed mathematics as masculine subject had higher level of aspiration in mathematics for their sons.

In his study Hattie (1984) investigated the relationships between home environment (father education level, mother education level and their expectations from child about their mathematics achievement), self-concept, and academic achievement. The study was carried out in Korea. The sample consisted of students ranging in age between 14 and 15 years old corresponding to the first grade of high school. Sample size was 2297. He found that self-concept was mediating variable between home environment and academic achievement. The results did not support the commonly held view that home environment exerts direct effects on academic achievement.

Wang, Wildman, Calhaun (1996) investigated the relationships between parental influence and student achievement through analyses of the Longitudinal Study of American Youth (LSAY) database. Information was collected from 3000 seventh grade students. Multiple regression correlation was used to analyse data. They found that not all-parental variables investigated in LSAY had significant relations with students' mathematics achievement at seventh grade. Significant parental variables were father education level, mother education level, parents:

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

expect college degree, parents: by me math and science game books, parents: confident in my ability, parents: help me with my homework, parents: reward good grades, parents: expect me do well in science, parents: informed about political and social issues, parents: vote in most elections, parents: read a lot books.

2.2.7 Summary of the findings of Previous Studies

1. Research literature has failed to provide consistent finding between ATM and AIM. While some studies demonstrated that the ATM and AIM correlation is quite low ranging from zero to 0.25 in absolute value (Abrego, 1966; Wolf and Blixt, 1981). The others concluded that the strong relationship between ATM – AIM with correlations above 0.40 (Aiken, 1971 & 1976; Kloosteman, 1981; Randhava & Beamer, 1982; Minato & Yenase, 1984).
2. There is a reciprocal relationship between ATM – AIM (Revicki, 1982; Feather, 1988; Ma & Kishor, 1997; Ma, 1997).
3. Students regard mathematics as a useful and important discipline to study (Khamis & Shotwell; ????; Carpenter & Corbit, 1980; Corbit, 1984; Jayne, 1990; Vanayan, 1997).
4. Research studies about confidence in learning mathematics indicates the importance of this affective variable in relation to students' achievement in mathematics (Crosswhite, 1972; Fennema & Sherman, 1977 & 1978; Marsh, Relich & Simith, 1983; Marsh, Parker & Barnes, 1985).
5. Students' success attribution is another important affective variable that affects achievement in mathematics (Wolleat, Pedro, Becker, and Fennama, 1980; Reyes,1984; TIMSS, 1997).
6. There is a negative correlation between anxiety in mathematics and achievement in mathematics (Drager & Aiken, 1957; Alpert, Stellwagen & Becker, 1963; Degnan, 1967; Carpenter, 1980; Holden, 1987;).
7. The results from the literature on gender differences in attitudes toward mathematics and achievement in mathematics are not clear. Some studies have reported that boys display more

favourable attitudes toward mathematics than girls do (Kaczala, 1981; Gwizdala & Steinback, 1988; Fennema & Carpenter, 1981; Hanna, 1986; Messer, 1993; Ma, 1995). Other studies, however, reported more positive attitudes to mathematics from girls (Dungan & Thurlow, 1989). Moreover, other investigations have reported no significant differences between boys' and girls' attitudes toward mathematics (Aiken, 1976; Hilton & Berglund, 1982; Kavrell & Peterson, 1984; Hall & Hoff, 1988).

8. Teachers' beliefs about mathematics, expectations, attitudes toward mathematics are important for how they interact with and teach their children. Then, these attitudes can be seen as an influence on the development of the students' attitudes toward mathematics (Garner, 1963; Torrance, 1966; Fennema, Peterson, Carpenter & Lubinski, 1990; Karp, 1991; Austin & Wodlington, 1992; Carter & Norwood, 1997).
9. Variability in student math achievement can be explained by the significant parental variables: mother education level, father education level, mother's expectation from child about learning mathematics, father's expectation from child about learning mathematics (Proffenberger & Norta, 1959; Alper, 1963; Hill, 1967; Hattie, 1984; Wang, Wildman & Callahun, 1996).

These summary results suggests that there is a need for research to investigate reciprocal relationship between attitudes toward mathematics and achievement in mathematics by including percieved father and mother characteristics related to students, father and mother education levels, percieved teacher characteristics related to students and percieved teacher characteristics related to profession, success attribution in mathematics, mathematics anxiety, confidence in learning mathematics, mathematics as a male domain, importance of mathematics, usefulness of mathematics and enjoy with mathematics variables.

CHAPTER 3

METHOD OF THE STUDY

This chapter includes explanation of problem and hypotheses of the present study, research design, subjects of the study, definition of the terms, variables, measuring instruments, tools for data analysis and explanation of internal and external validity.

3.1 Problem of the Present Study and Associated Hypotheses

The problems of the present study are the following:

1. What structural model best describes the reciprocal relationship between Attitudes toward Mathematics (ATM) and Achievement in Mathematics (AIM)?
2. What role does each selected variables play in the model with respect to the reciprocal relationship between ATM and AIM?

Following hypotheses are stated in order to test the problems:

1. There is a reciprocal relationship between ATM and AIM.
2. There is a significant effect of father quality on ATM
3. There is a significant effect of father quality on AIM
4. There is a significant effect of mother quality on ATM
5. There is a significant effect of mother quality onAIM
6. There is a significant effect of teacher quality on ATM
7. There is a significant effect of teacher quality on AIM.

They were tested at the level of significance $\alpha = 0.01$

On the basis of theoretical background and literature review following model was hypothesized. All paths in the model were driven from the literature review and the theoretical assumptions.

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

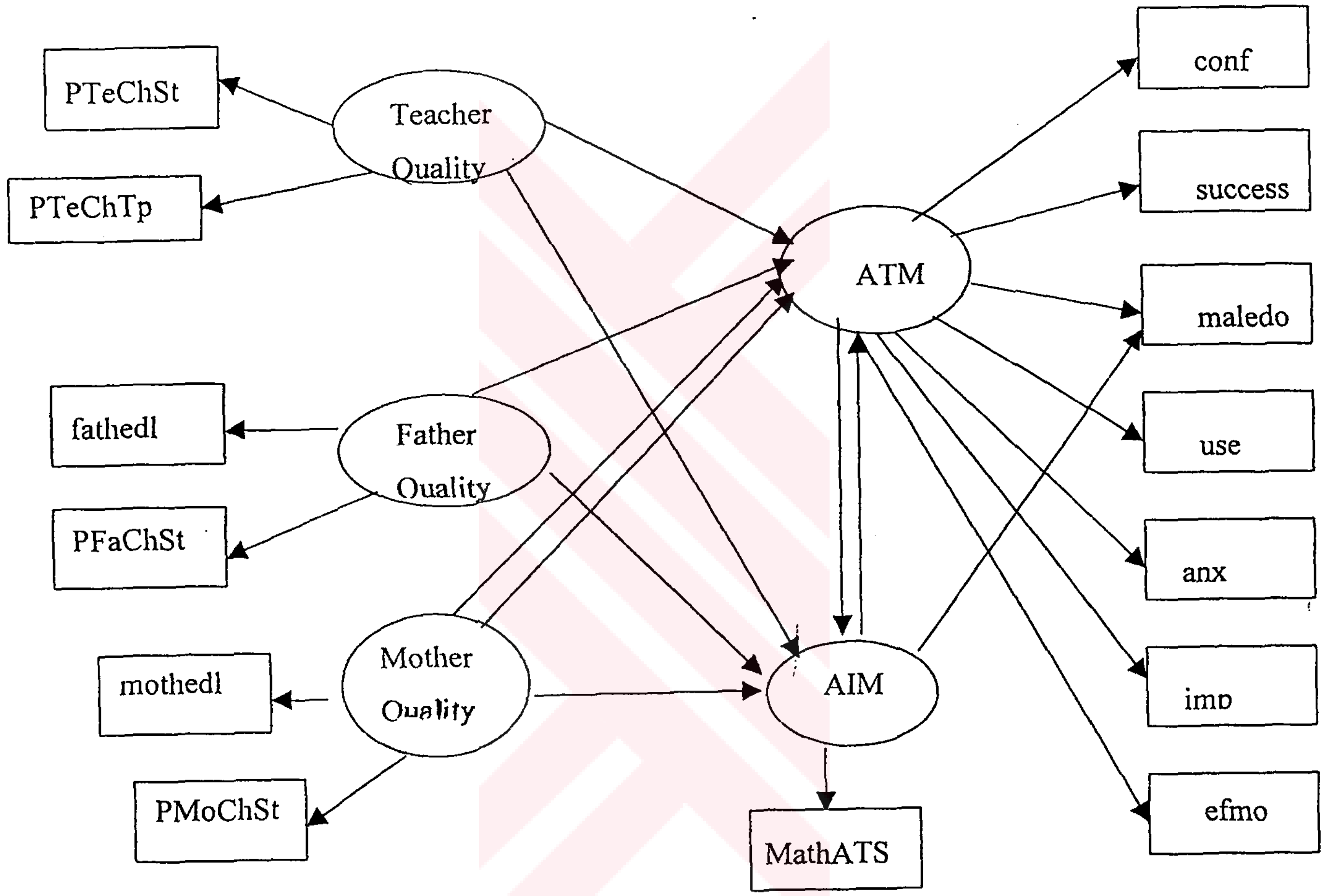


Figure 3.7.1 Hypothesised Model of the Present Study

3.2 Research Design

In the present study correlational research design are used to describe the relationship between attitudes toward mathematics and achievement in mathematics.

3.3 Subjects of the Study

The subjects of the study consisted of 951 nineth grade students in private, academic and Anatolian Lyceé in Ankara-Turkey. Convenient sampling was used. The study carried out during the 1999-2000 academic year. The distribution of the subjects is given in Table3.3.1

Table 3.3.1 Distribution of Subjects of the Present Study

School	Gender		TOTAL
	Girl	Boy	
Gazi Anatolian Lyceé	180	221	401
Mehmet Emin Resülzade Lyceé (MERAL)	78	111	189
Türk Eğitim Vakfı Ankara College (TED)	74	117	191
Kılıçaslan Lyceé	53	39	92
Niğbolu Lyceé	35	43	78
TOTAL	420	531	951

3.4 Definition of the Terms

The definitions of the terms used in this study are given below to clarify and avoid possible semantic difficulties.

1. **Structural equation model** refers to statistical technique that specifies certain relationships among the latent variables depicted lines or arrows.
2. **Latent variables** refer to variables that are not directly observable or measured; they must be observed or measured indirectly, hence, inferred. For example, intelligence is latent variable. Intelligence can be indirectly measured through observed or indicator variables.
3. **Latent dependent variable** refers to any latent variable that is influenced by some other latent variable in the model.
4. **Latent independent variable** refers to any variable that is not influenced by any other variable in the model.
5. **Observed or indicator variables** refer to variables that are directly observable or measured.
6. λ_x , λ_y refers to coefficients between latent variables and observed variables. They provide us with information about the extent to which a given observed variable is able to measure the latent variable. They serve as a validity coefficient.
7. **Measurement error** refers to portion of an observed variable that is measuring something other than what the observed variable is hypothesized to measure. It serves as a measure of relaibility.
8. γ refers to coefficients that indicate the strength (weak or strong) and direction (positive or negative) of the relationship among the latent dependent and latent independent variables.
9. β refers to coefficients that indicate the strength (weak or strong) and direction (positive or negative) of the relationship among the latent dependent and latent dependent variables.
10. **Attitudes toward mathematics** (ATM) refers to an aggregated measure of a liking or disliking of mathematics, a tendency of engage in or avoid mathematical activities, a perception about usefuness and importance of

mathematics, feeling of anxiety, and perception of mathematics as a bor or girl domain.

11. **Affective variables** refer to students' feelings about mathematics, aspects of the classroom, or about themselves as learners of mathematics (Reyes, 1984).
12. **Usefulness of mathematics** (use) refers to students' beliefs about the usefulness of mathematics currently and in relationship to their future education, vocation or other activities .
13. **Importance of mathematics** (imp) refers to students' beliefs about the importance of mathematics in relationship to their life .
14. **Effectance motivation** (efmo) refers to students' involvement in mathematics, active enjoyment of seeking of challenge, interest or enjoyment of mathematics .
15. **Confidence in learning mathematics** (conf) reefers to students' beliefs about their ability to learn and perform well on mathematical tasks. The dimensions range from distinct lack of confidence to definite confidence.
16. **Success attribution in mathematics** (success) refers to students' anticipation about positive or negative consequences as a result of success in mathematics .
17. **Mathematics anxiety** (anx) refers to feelings of anxiety, dread, nervousness, and associated bodily symptoms related to doing mathematics. The dimensions range from feeling at ease to those distinct anxieties.
18. **Math as a male domain** (maledo) refers to students' perceptions about mathematics as a boy, or girl domain. The dimensions were the relative ability of the genders to perform in math, the masculinity/femininity of those who achieve well in mathematics and the appropriateness of this line of study for boys and girls.
19. **Percieved teacher characteristics related to students** (PTeChSt) refers to students' perceptions of their teachers' attitude toward them as learners of mathematics. It includes teachers' interest, encouragement and confidence in the students' ability .

20. **Percieved teacher characteristics related to profession** (PTeChTp) refers to students' perceptions of their teacher's teaching profession.

21. **Teacher quality** refers to students'' perceptions of their teachers' attitudes toward them as learners of mathematics and toward teaching of mathematics. It includes teacher's interest, encouragement and confidence in the students` ability.

22. **Percieved father caharacteristics related to students** (PFaChSt) refers to students' perception of their father's attitudes toward them as learners of mathematics. It also includes father interest, encouragement, and confidence in the student's ability.

23. **Father quality** refers to refers to students' perception of their father's attitudes toward them as learners of mathematics. It also includes father interest, encouragement, confidence in the student's ability, and father education level.

24. **Percieved mother characteristics related to students** (PMoChSt) refers to students' perception of their mother's attitudes toward them as learners of mathematics. It also includes mother interest, encouragement, and confidence in the student's ability.

25. **Mother quality** refers to students' perception of their mother's attitudes toward them as learners of mathematics. It also includes mother interest, encouragement, confidence in the student's ability, and mother education level.

26. **Achievement in mathematics** (AIM) refers to student's' performance on mathematics achievement test which is developed by the researcher. It also includes students' perceptions of mathematics as a boy or girl domain.

T.C. YÜKSEKÖĞRETIM KURULU
DOKÜMANTASYON MERKEZİ

3.5 Variables

In the present study variables are categorised as latent independent, latent dependent and observed. Distribution of the variables is given in Table 3.2.

Table 3.5.1 Distribution of the Variables of the Present Study

Latent Variables		Corresponding Observed Variables
Dependent	Independent	
1.ATM		1.1 Effectance Motivation (efmo)
		1.2 Usefulness of Math (use)
		1.3 Importance of Math (imp)
		1.4 Confidence in Learning Mathematics (conf)
		1.5 Success Attribution in Mathematics (success).
		1.6 Mathematics Anxiety (anx)
		1.7 Mathematics as a Male Domain (maledo)
2.AIM		2.1 Mathematics Achievement Test Scores (MathATS)
		2.2 Mathematics as a Male Domain (maledo)
	3. Teacher Quality	3.1 Percieved Teacher Characteristics Related to Students (PteChST)
		3.2 Percieved Teacher Characteristics Related to Profession (PteChTp)
	4. Father Quality	4.1 Percieved Father Characteristics Related to Students (PfaChSt)
		4.2 Father Education Level (fathedl)
	5. Mother Quality	5.1 Percieved Mother Characteristics related to Stuedents (PmoChSt)
		5.2 Mother Education Level (mothedl)

3.6 Measuring Instruments

In the study following measuring instruments were used

1. Mathematics Achievement Test (MAT)
2. Father Scale
3. Mother Scale
4. Teacher Scale I
5. Teacher Scale II
6. Confidence in Learning Mathematics Scale
7. Attitude toward Success in Mathematics Scale
8. Mathematics as a Male Domain Scale
9. Usefulness of Mathematics Scale
10. Mathematics Anxiety Scale
11. Effectance Motivation Scale
12. Mathematics Importance Scale

The development process of each measuring instrument is explained below.

3.6.1 Mathematics Achievement Test (MAT)

This test was developed by the researcher to determine whether or not students acquired basic mathematical skills that have to be in ninth grade (see Appendix A). Content of the test was determined according to the Ministry of National Education's elementary school mathematics curriculum (MEB, 1990).

Objectives were written in the comprehension and application levels as defined by Bloom's Taxonomy. In addition table of specifications was prepared (see Appendix B). Twenty-five items were written according to the table of specification.

Pilot study of MAT was conducted in Türk Eğitim Derneği (TED) Ankara College, Gazi Anatolian Lyceé, Mehmet Emin Resülzade Anatolian Lyceé (MERAL), Kılıçaslan Lyceé, Niğbolu Lyceé in 1999-2000 academic year. 353 ninth grade students were involved in the study.

Before adminestration of the MAT, mathematics education expert and the mathematics teacher checked the content validity of MAT. The administration of the test was held in one class hour. An item analysis of these data was accomplished by using the ITEMAN program. The ITEMAN program indicated item discrimination power as biserial coefficient and item difficulty power as the percentage of the correct responses to each item. The criterion was that item discrimination power should be greater than or equal to 0.2. The criterion for item difficulty power was that the coefficient should be between 0.2 and 0.8. According to these criterions, the item discrimination powers and item difficulty powers of each item were analysed. Five items were eliminated from MAT because their discrimination powers and item difficulty powers were near to 0.2. After these steps, the mathematics education expert and the mathematics teacher checked the content validity of MAT. The alpha reliability coefficient of the MAT with 20-items was found as 0.81 by using the Statistical Packages for Social Sciences (SPSS). The total score of MAT was out of 20.

3.6.2 Scales

Eleven scales were formed by adaptation of Fennema-Sherman Attitude scale (1986) and TIMSS Attitude Scale (1999). They were used to measure observed variables of the latent variables: attitudes toward mathematics, teacher, father and mother quality. Each item was translated back into Turkish by the researchers and expert in Foreign Language Education. And then the scales were translated back into English by the researcher, and original scales compaired with the adapted scales. After that scales were administered in TED Ankara College, Gazi Anatolian Lyceé, MERAL, Kılıçaslan Lyceé and Niğbolu Lyceé in 1999-2000 academic year. 353 ninth grade students were involved in the pilot study.

Data were analysed by using SPSS. There were 124 items. They were scaled on a five-point Likert Type Scale: Strongly Agree, Agree Undecided, Disagree, and Strongly Disagree. The positively worded items were scored from Strongly Agree as 5, to Strongly Disagree as 1, and negatively worded items were reversed to positive direction for scoring purposes.

To test the construct validity of each scale and to determine whether or not they have subdimensions factor analysis was done. The alpha reliability coefficients for each scale calculated with the SPSS package program. For each scale following results were obtained.

3.6.2.1 Father Scale

Father scale was adapted from Fennema- Sherman Attitude Scale (1986) to measure students' perception of their father's attitudes toward them as learners of mathematics. It includes students' perception of father interest, encouragement, and confidence in the student's ability. There were 11 items in the scale, 6 of them positively stated and 5 of them negatively stated. For example, one of the item is "My father has always been interested in my progress in mathematics"

According to the initial principal factor solution with iterations, the eigen-values of 11 items were 4.95, 1.45, 1.10, 0.83, 0.64, 0.51, 0.45, 0.34, 0.33, 0.26, and 0.19. The factor loadings of them were given in Table 3.6.1

Table 3.6.1 Factor Loadings of Father Scale

	Component
	1
2	,789
3	,787
9	,704
10	,689
8	,688
11	,680
1	,677
6	,672
4	,664
5	,658
7	,133

After varimax rotation their eigen-values remained the same, positively stated items came together under the factor 2, negatively stated items came together under the factor 1, which indicates that Father Scale has no subdimensions. Its alpha reliability coefficient is 0.85.

The same analyses were carried out with the data collected from 951 subjects. The similar results were obtained like in the pilot study.

3.6.2.2 Mother Scale

Mother scale was adapted from Fennema- Sherman Attitude Scale (1986) to measure students' perception of their mother's attitudes toward them as learners of mathematics. It includes students' perception of mother interest, encouragement, and confidence in the student's ability. There were 11 items in the scale, 6 of them positively stated and 5 of them negatively stated. For example one of the item is "My mother wouldn't encourage me to plan a career which includes mathematics".

According to the initial principal factor solution with iterations, the eigen-values of 11 items were 4.04, 1.43, 1.07, 0.93, 0.85, 0.66, 0.58, 0.50, 0.42, 0.33, and 0.21. The factor loadings of them were in Table 3.6.2

Table 3.6.2 Factor Loadings of Mother Scale

	Component
	1
4	,721
8	,714
3	,708
2	,670
1	,647
10	,622
5	,614
11	,569
7	,465
9	,315
6	,487

After varimax rotation their eigen-values remained the same, positively stated items came together under the factor 2, negatively stated items came together under the factor 1, which indicates that Mother Scale has no subdimensions. Its alpha reliability coefficient is 0.82.

The same analyses were carried out with the data collected from 951 subjects. The similar results were obtained.

3.6.2.3 Teacher Scale I

Teacher Scale I was adapted from Fennema- Sherman Attitude Scale (1986) to measure students' perception of their teacher's attitudes toward them as learners of mathematics. It includes students' perception of teacher interest, encouragement, and confidence in the student's ability. There were 12 items in the scale, 6 of them positively stated and 6 of them negatively stated. For example, one of the item is "Mathematics teachers think I'm the kind of person who could do well in mathematics".

According to the initial principal factor solution with iterations, the eigen-values of 12 items were 4.26, 1.97, 0.86, 0.79, 0.76, 0.68, 0.63, 0.53, 0.48, 0.39, 0.36, and 0.28. The factor loadings of them were in Table 3.6.3

Table 3.6.3 Factor Loadings of Teacher Scale I

	Component
	1
3	,743
5	,716
4	,715
2	,711
10	,604
12	,602
1	,580
6	,561
11	,540
9	,461
8	,438
7	,327

After varimax rotation their eigen-values remained the same, positively stated items came together under the factor 1, negatively stated items came together under the factor 2, which indicates that Teacher Scale I has no subdimensions. Its alpha reliability coefficient is 0.79.

The same analyses were carried out with the data collected from 951 subjects. The similar results were obtained like in the pilot study.

3.6.2.4 Teacher Scale II

Teacher Scale II was adapted from TIMSS (1999) to measure students' perception of teacher's teaching profession. There were 7 items in the scale, 5 of them positively stated and 2 of them negatively stated. For example, one of the item is "My mathematics teachers like mathematics".

According to the initial principal factor solution with iterations, the eigen-values of 7 items were 3.01, 0.98, 0.87, 0.74, 0.55, 0.50, and 0.36. The factor loadings of them were in Table 3.6.4

Table 3.6.4 Factor Loadings of Teacher Scale II

	Component
	1
3	,829
5	,751
4	,697
7	,574
2	,572
6	,558
1	,550

After varimax rotation their eigen-values remained the same, all items came together under the first factor, which indicates that Teacher Scale II has no subdimensions. Its alpha reliability coefficient is 0.79.

The same analyses were carried out with the data collected from 951 subjects. The similar results were obtained like in the pilot study.

3.6.2.5. Confidence in Learning Mathematics Scale

Confidence in Learning Mathematics Scale was adapted from Fennema-Sherman Attitude Scale (1986) to measure confidence in one's ability to learn and perform well on mathematical tasks. There were 12 items in the scale, 6 of them positively stated and 6 of them negatively stated. For example, one of the item is "I am sure that I can learn mathematics".

According to the initial principal factor solution with iterations, the eigen-values of 12 items were 6.75, 1.10, 0.79, 0.66, 0.49, 0.44, 0.39, 0.35, 0.30, 0.28, 0.23, and 0.21. The factor loadings of them were given in Table 3.6.5

Table 3.6.5 Factor Loadings of Confidence in Learning Mathematics Scale

Component Matrix

	Component
	1
6	,803
7	,792
11	,792
9	,781
1	,775
12	,758
2	,747
4	,745
5	,730
3	,704
8	,698
10	,666

After varimax rotation their eigen-values remained the same, negatively stated items came together under the first factor and positively stated items came together under the second factor which indicates that Confidence in Learning mathematics Scale has no subdimensions. Its alpha reliability coefficient is 0.93.

The same analyses were carried out with the data collected from 951 subjects. The similar results were obtained like in the pilot study.

3.6.2.6 Attitude Toward Success in Mathematics Scale

Attitude toward Success in Mathematics Scale was adapted from Fennema- Sherman Attitude Scale (1986) to measure the degree to which students anticipate positive or negative consequences as a result of success in mathematics. There were 12 items in the scale, 6 of them positively stated and 6 of them negatively stated. For eaxmple, one of the item is “Being regarded as smart in mathematics would be a great thing”.

According to the initial principal factor solution with iterations, the eigen-values of 12 items were 4.99, 2.56, 1.05, 0.73, 0.65, 0.57, 0.44, 0.40, 0.33, 0.27, 0.19, and 0.14. The factor loadings of them were given in Table 3.6.6

Table 3.6.6. Factor Loadings of Attitude toward Success in Mathematics Scale

	Component	
	1	2
3	,830	
2	,826	
6	,816	
1	,803	
5	,787	
4	,785	
11		,444
9		,668
10		,661
12		,605
8		,309
7		,481

After varimax rotation their eigen-values remained the same, positively stated items came together under the first factor and negatively stated items came together under the second factor which indicates that Success Attribution in Learning Mathematics Scale has no subdimensions. Its alpha reliability coefficient is 0.83.

The same analyses were carried out with the data collected from 951 subjects. The similar results were obtained like in the pilot study.

3.6.2.7 Mathematics as a Male Domain Scale

Mathematics as a Male Domain Scale was adapted from Fennema- Sherman Attitude Scale (1986) to measure students' perceptions about mathematics as a boy or girl domain. There were 12 items in the scale, 6 of them positively stated and 6 of them negatively stated. For example, one of the item is "It's hard to believe a female could be a genius in mathematics".

According to the initial principal factor solution with iterations, the eigen-values of 12 items were 5.81, 1.27, 0.89, 0.74, 0.64, 0.54, 0.51, 0.43, 0.40, 0.35, 0.25, and 0.19. The factor loadings of them were given in Table 3.6.7

Table 3.6.7 Factor Loadings of Mathematics as a Male Domain Scale

Component Matrix

	Component
	1
3	,801
4	,800
7	,785
2	,783
11	,746
9	,728
10	,715
8	,674
12	,647
6	,631
1	,590
5	,289

After varimax rotation their eigen-values remained the same, negatively stated items came together under the first factor and positively stated items came together under the second factor which indicates that Math as a Male Domain Scale has no subdimensions. Its alpha reliability coefficient is 0.89.

The same analyses were carried out with the data collected from 951 subjects. The similar results were obtained like in the pilot study.

3.6.2.8 Usefulness of Mathematics Scale

Usefulness of Mathematics Scale was adapted from Fennema- Sherman Attitude Scale (1986) to measure students' beliefs about the usefulness of mathematics currently and in relationship to their future education and vocation. There were 12 items in the scale, 6 of them positively stated and 6 of them negatively stated. For example, one of the item is "I will need mathematics for my future work".

According to the initial principal factor solution with iterations, the eigen-values of 12 items were 6.52, 1.37, 0.66, 0.55, 0.52, 0.45, 0.42, 0.38, 0.36, 0.30, 0.27, and 0.23. The factor loadings of them were given in Table 3.6.8

Table 3.6.8 Factor Loadings of Usefulness of Mathematics Scale

	Component
	1
4	,797
5	,768
8	,758
3	,752
6	,738
12	,727
10	,727
2	,724
9	,719
1	,717
7	,715
11	,695

After varimax rotation their eigen-values remained the same, negatively stated items came together under the first factor and positively stated items came together under the second factor which indicates that Usefulness of Mathematics Scale has no subdimensions. Its alpha reliability coefficient is 0.92.

The same analyses were carried out with the data collected from 951subjects. The similar results were obtained like in the pilot study.

3.6.2.9 Mathematics Anxiety Scale

Mathematics Anxiety Scale was adapted from Fennema- Sherman Attitude Scale (1986) to measure feelings of anxiety, dread, nervousness and associated bodily symptoms related to doing mathematics. There were 12 items in the scale, 6 of them positively stated and 6 of them negatively stated. For example, one of the item is "Mathematics usually makes me feel uncomfortable, and nervous".

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

According to the initial principal factor solution with iterations, the eigen-values of 12 items were 5.97, 1.68, 1.01, 0.66, 0.56, 0.48, 0.40, 0.34, 0.33, 0.22, 0.19, and 0.18. Its factor loadings of them were given in Table 3.6.9

Table 3.6.9 Factor Loadings of Mathematics Anxiety Scale

	Component
	1
3	,793
1	,776
11	,758
12	,750
7	,735
9	,725
8	,713
5	,691
10	,666
6	,657
4	,654
2	,494

After varimax rotation their eigen-values remained the same, negatively stated items came together under the first factor and positively stated items came together under the second factor which indicates that Mathematics Anxiety Scale has no subdimensions. Its alpha reliability coefficient is 0.91.

The same analyses were carried out with the data collected from 951 subjects. The similar results were obtained like in the pilot study.

3.6.2.10 Effectance Motivation Scale

Mathematics Anxiety Scale was adapted from Fennema- Sherman Attitude

Scale (1986) to measure interest or enjoyment of mathematics. There were 12 items in the scale, 6 of them positively stated and 6 of them negatively stated. For example, one of the item is "Mathematics is enjoyable and stimulating to me".

According to the initial principal factor solution with iterations, the eigen-values of 12 items were 5.48, 1.31, 0.98, 0.83, 0.66, 0.59, 0.47, 0.44, 0.40, 0.33, 0.31, and 0.21. Its factor loadings of them were given in table 3.6.10

Table 3.6.10 Factor Loadings of the Effectance Motivation Scale

	Component
	1
2	,790
9	,789
1	,761
7	,744
4	,742
8	,686
3	,679
11	,650
10	,650
5	,640
12	,565
6	,202

After varimax rotation their eigen-values remained the same, positively stated items came together under the first factor and negatively stated items came together under the second factor which indicates that Effectance Motivation Scale has no subdimensions. Its alpha reliability coefficient is 0.81.

The same analyses were carried out with the data collected from 951 subjects. The similar results were obtained like in the pilot study.

3.6.2.11 Importance of Mathematics Scale

Importance of Mathematics Scale was adapted from TIMSS (1999) to measure students' beliefs about importance of mathematics in relationship to their life. There were 5 items in the scale, 5 of them positively stated. For example, one of the item is "Mathematics is important to everyone's life".

According to the initial principal factor solution with iterations, the eigen-values of 5 items were 2.53, 0.85, 0.67, 0.58, and 0.36. The factor loadings of them were given in Table 3.6.11

Table 3.6.11 Factor Loadings of Importance of Mathematics Scale

	Component
	1
5	,809
3	,766
1	,712
4	,710
2	,528

After varimax rotation their eigen-values remained the same, all items came together under the first factor, this indicates that Importance of Mathematics Scale has no subdimensions. Its alpha reliability coefficient Scale is 0.69.

The same analyses were carried out with the data collected from 951 subjects. The similar results were obtained like in the pilot study.

3.7 Data Analysis

All hypotheses of the present study were analysed by utilising statistical technique called Structural Equation Modelling. For this purpose Linear Structural Relations (LISREL)-8.30 statistics package program was used.

Methodologically, multiple regression seeks to identify and estimate the amount of covariance in the dependent variable attributed to one or more independent variables. Path analysis seeks to identify subsets of variables with common shared variance from a much large set, or to confirm measurement model where variables are hypothesised to define a construct.

Structural equation modelling builds on these methods by incorporating a confirmatory factor analysis approach into the theoretical relationships among the latent variables (Ma & Kishor, 1997).

Regression analysis has been used as a legitimate approach to providing unbiased prediction of the dependent variable. It is an advantage in that the estimated regression coefficients generate unbiased predictions based on the given values of the predictors. However, it is also a disadvantage in that researchers have difficulty deciding "whether the predictors are intact causally prior to, causally unrelated to, or causally determined by the dependent variable." Statistical techniques such as structural equation modelling take this problem into account and enable researchers to make inference about causal relationships (Schiebeci & Riley, 1986).

In a structural equation model, unknown parameters are estimated so that variances and covariances of the variables in the model. Model parameters can not be estimated without a computer program because no algebraic solution is available. Rather, the researcher provides initial estimates ("starting values") which are refined through interactive procedures, least squares (two stage least square, unweighted least square, and weighted least square) and maximum likelihood (Schiebeci & Riley, 1986).

The least squares and maximum likelihood methods are used to estimate the parameters in the computer program LISREL (Jöreskog & Sörbom, 1978). The model underlying this program can be used to estimate a variety of causal models, including those containing errors in latent variables (errors of measurement), and errors in equations (residuals).

The LISREL model thus enables the researcher to analyse causal networks with latent variables and measurement errors. It assumes that there is a causal structure among a set of latent variables and set of observed variables are manifestations of these latent variables or "hypothetical constructs." The LISREL model is described by the specification of structural relationships among the latent variables (the structural equation model) and the specification of the relationships among the latent and observed variables (the measurement model) (Jöreskog & Sörbom, 1978).

In conclusion, structural equation models helps to establish the relationship between latent variables or constructs given a theoretical perspective. The structural equation modelling approach involves developing measurement models to define latent variables and then establishing relationships or structural equations among the latent variables (Schumaker & Lomax, 1996)

The five steps that characterise most structural equation modelling application were listed in Bollean and Long (1993):

1) Model specification
2) Identification
3) Estimation
4) Testing fit
5) Respecification

The first step, model specification, refers to the initial theoretical model the researcher formulates. This model hypothesised on the basis of a review of the literature in mathematics education and on the basis of theories. The second step, identification is to ask whether unique values can be found for the parameters to be estimated in the theoretical model. The third step, estimation, requires knowledge of the various estimation techniques that are used depending on the variable scale and/or distributional property of the variables used in the model. The fourth step, testing fit, involves interpreting model fit or comparing fit indices for alternative or nested models. The fifth step, respecification, usually occurs when the model fit indices suggest a poor fit. In this instance decision model regarding how to delete, add, or modify paths in the model and then subsequently reruns the analysis.

The abbreviations used in the model are as follows

Attitudes toward mathematics	ATM
Achievement in mathematics	AIM
Mathematics Achievement Test Score	MathATS
Confidence in learning mathematics	conf
Success attribution in mathematics	success
Math as a male domain	maledo
Usefulness of mathematics	use
Anxiety in mathematics	anx
Importance of mathematics	imp
Effectance motivation	efmo
Percieved Characteristics of Teacher Related to Students	PTeChSt
Percieved Teacher Characteristics Related to Profession	PTeChTP
Percieved Mother Characteristics Related to Students	PMoChSt
Percieved Father Charecteristics Related to Students	PFaChSt
Father Education Level	fathedl
Mother Education Level	mothedl

In present study reciprocal model of the relationship between ATM and AIM is described in Figure 3.1. Observed variables are enclosed in rectangles, latent variables are enclosed in ellipse. All paths in the model were driven from the literature review and the theoretical assumptions.

Unweighted Least Square used to estimate this theoretical model. Unweighted Least Square Method uses covariance matrix for analyses. Significance of the model parameters was tested through t-values. The LISREL 8.30 program calculates the ratio of the parameter estimate to the standard error and therefore equivalent to a z-test. In the path diagram only path that have significant t-value are included. Assessment of the model fit was based on multiple criteria including the goodness of fit index (GFI), adjusted goodness of fit index (AGFI), the root mean square residual (RMSR), which is the average difference between the observed correlations and the values estimated by the model and model comparison. A GFI and AGFI above 0.90 and RMSR below 0.05 jogged as good fitting.

3.8 Limitations

3.8.1 Internal Validity

Internal validity means that any relationship observed between two or more variables should be unambiguous and being due to "something else." The "something else" may be the age or ability of the subjects, the conditions under which the study is conducted, or the type of materials used (Fraenkel and Wallen, 1996).

The selection of people for study may result in the individuals (or groups) differing from one another in unintended ways that is related to the variables to be studied. This is called subject characteristics threat (Fraenkel and Wallen, 1996). In the present study subject characteristics could not be a problem for the internal validity. Subjects were all ninth grade students. Genders of the subjects were included as a variable. However, subjects' socioeconomic backgrounds were not equal because of the school types that were included. Since subjects' parents' education level included as a variable effect of socioeconomic background tried to be controlled.

Lose of subjects as the study progress is known as mortality threat (Fraenkel & Wallen, 1996). In the present study mortality could not be a problem for the internal validity. Subjects were not known when they were get attitude scales and achievement test.

The particular locations which data are collected are called a location threat (Fraenkel & Wallen, 1996). In the present study location could not be a problem for the internal validity. The classroom settings in which data were collected were similar to each other.

The way in which instruments are used may also constitute a threat to internal validity of the study (Fraenkel & Wallen, 1996). Instrument decay, data collector characteristics, and data collector bias could not be problem to internal validity. The computer read data. Data collector characteristics were not related to the variables being investigated. Data were collected in the same way from all schools.

Since the present study is not an intervention or experimental study testing, maturation, Hawthorne effect, regression, implementation could not be problem for the internal validity. Because there weren't any unplanned occasions during the implementation of the attitude scales and achievement test, history could not be a problem for the internal validity. Confidentiality was satisfied without taking accounts the names of the subjects.

3.8.2 External Validity

3.8.2.1 Population Validity

In the present study convenience sampling was utilised. However, all types of the schools tried to be included. Except Science Lycee, Anatolian Lycee, private Lycee, and Public Lycee were included in the study. Nevertheless, since sample size was not big enough generalisations of the findings of the study were limited. On the other hand, generalisation can be done on subjects having the same characteristics mentioned in chapter 3.

3.8.2.2 Ecological Validity

The ecological validity refers to the degree to which results of a study can be extended to other settings or conditions (Fraenkel and Wallen, 1996). The results of the present study can be generalised to schools similar to this study.

CHAPTER 4

RESULTS OF THE STUDY

This chapter devoted to the presentation of results of the present study. It contains model evaluation and testing hypothesis sections

4.1 Model Evaluation

The problems of the present study were the following:

1. What structural model best describes the reciprocal relationship between Attitudes toward Mathematics (ATM) and Achievement in Mathematics (AIM)?
2. What role does each selected variables play in the model with respect to the reciprocal relationship between ATM and AIM?

The reciprocal relationship between ATM and AIM the Figure 3.7 was estimated using an Unweighted Least Square Linear Structural Model. The results of the analysis given in Figure 4 .1, Figure 4.2, Figure 4.3 and Table 4.1, Table 4.2 In Figure 4.1 coefficients are standardized, in Figure 4.2 coefficients are t-values in, Figure 4.3 model with error values, Table 4.1 λ values and corresponding measurement error are given, in Table 4.2 and Table 4.3 structure coefficients are given.

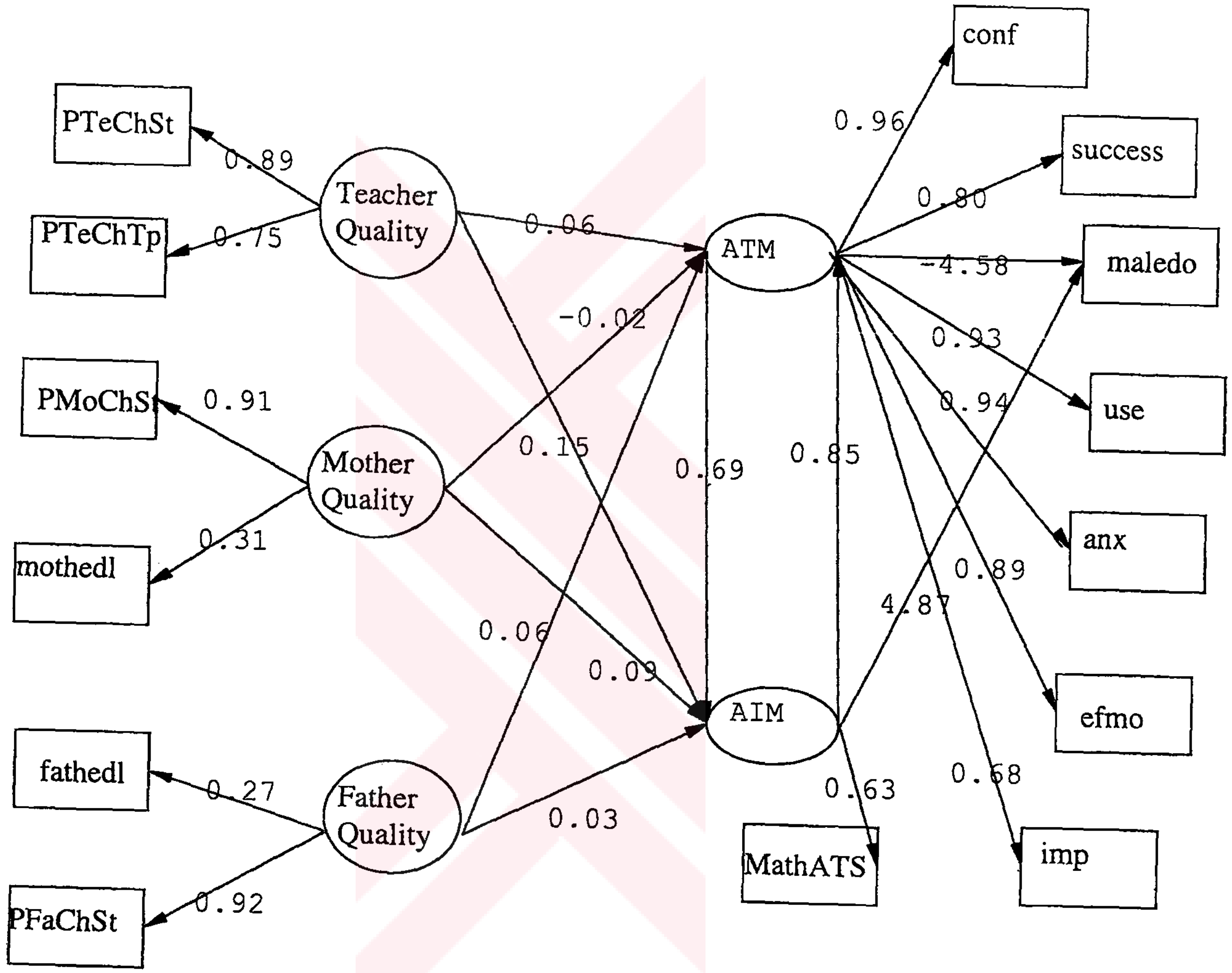


Figure 4.1 LISREL Estimates of Parameters in Measurement Model (Coefficients are in Standardized Value)

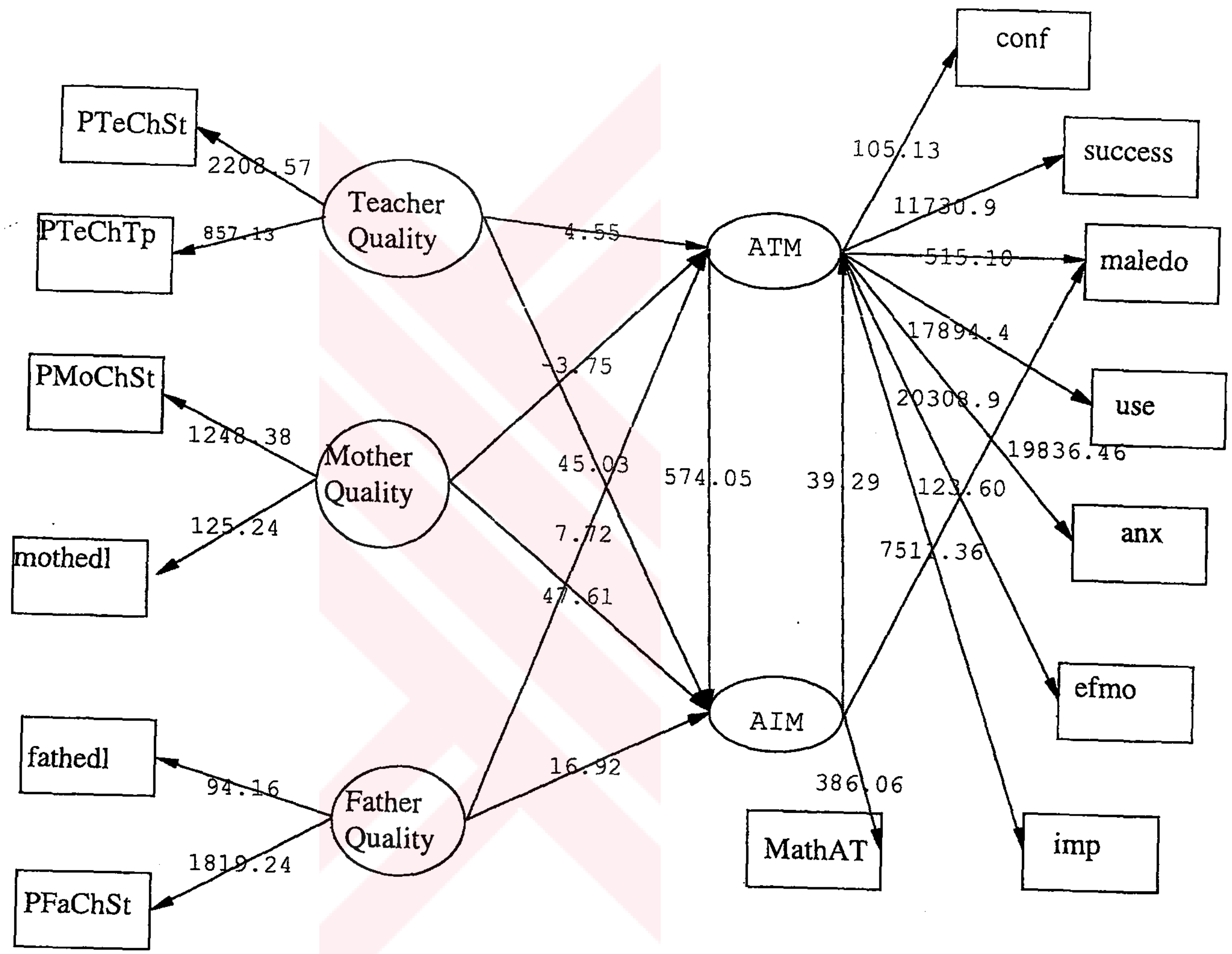


Figure 4.2 LISREL Estimates of Parameters in Measurement Model (Coefficients are in t-Values)

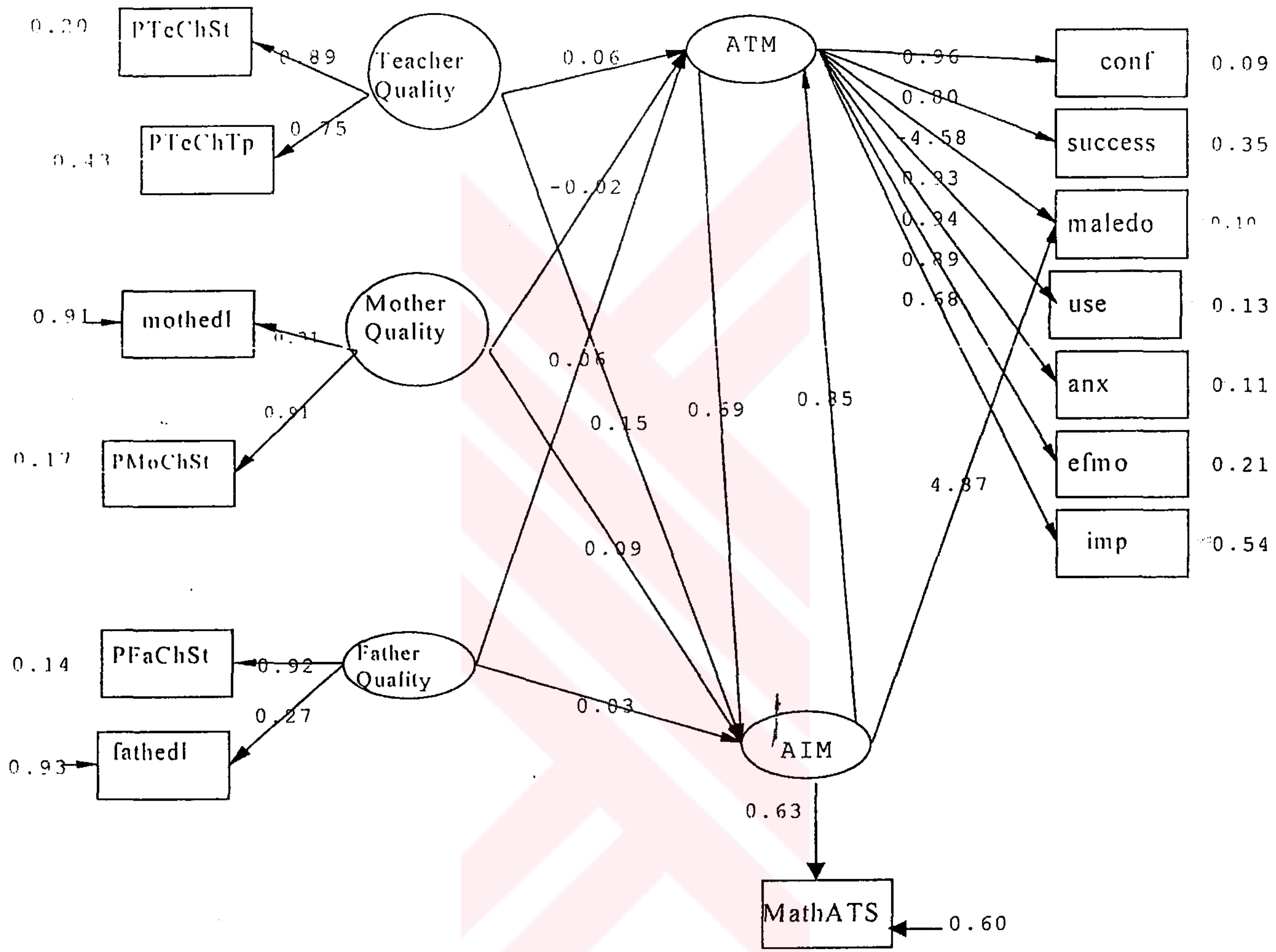


Figure 4.3 LISREL Estimates of Parameters in Measurement Model with Errors

Table 4.1 λ values and Corresponding Measurement Errors

Observed Variables	**λ**	**Latent Variables**	**Measurement Error**
conf	7.23 (λ_y)	ATM	5.00
Success	3.58(λ_y)		7.00
Maledo	-44.78(λ_y)		10.00
use	6.87(λ_y)		7.00
anx	8.40(λ_y)		9.00
efmo	7.99(λ_y)		17.00
imp	2.07(λ_y)		5.00
MatAT	1.26(λ_y)	AIM	4.00
Maledo	47.66(λ_y)		10.00
Fathedl	0.26(λ_x)	Father Quality	0.92
PFaChSt	6.43(λ_x)		7.00
Mathedl	0.36(λ_x)	Mother Quality	1.27
PMaChSt	5.33(λ_x)		6.00
PTeChSt	6.84(λ_x)	Teacher Quality	12.00
PTeChTp	2.28(λ_x)		4.00

Table 4.2 Structure Coefficients

Latent Independent Variables	γ	**Latent Dependent variables**
Teacher Quality (TQ)	0.064	ATM
Mother Quality (MQ)	-0.18	
Father Quality (FQ)	0.056	
Teacher Quality	0.15	AIM
Mother Quality	0.089	
Father Quality	0.025	

Table 4.3 Structure Coefficients

Latent Dependent Variables	β	**Latent Dependent Variables**
AIM	0.85	ATM
ATM	0.69	AIM

As can be seen from the Figure 4.1 structural model consists of three latent independent variables and two latent dependent variables. The latent independent variables are Teacher Quality Mother Quality, Father Quality while the two latent dependent variables are Attitude toward Mathematics (ATM) and Achievement in Mathematics (AIM). Confidence in learning mathematics (conf), Succsess attribution in mathematics (success), math as a male domain (maledo), usefulness of mathematics (use), mathematics anxiety (anx), effectance motivation (efmo), importance of mathematics (imp) are observed variables of the latent dependent variable ATM. Scores of the students on Mathematics Achievement Test (MAT) (matachv), math as male domain (maledo) are observed variables of latent dependent variable AIM.

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

Students' perception of their teacher's attitudes toward them as learners of mathematics including teacher interest, encouragement and confidence in the students' ability (PTeChSt), and students' perception of their teachers' attitudes toward profession (PTeChTp) are the observed variables of the latent independent variable Teacher Quality. Mother education level (mothedl), students' perception of their mother's attitudes toward them as learners of mathematics including mother interest and encouragement (PMoChSt) are the observed variables of the latent independent variable Mother Quality. Father education level (fathedl), students' perception of their father's attitudes toward them as learners of mathematics, father interest and encouragement (PFaChSt) are the observed variables of the latent independent variable Father Quality.

The LISREL model was evaluated by 1) the goodness of fit statistics (GFI), adjusted goodness of fit (AGFI) testing the extent to which the model was consistent with the data; 2) t-tests of specific path coefficients to determine whether each of the various hypothesised relationships had been confirmed; 3) Root Mean Square Residual (RMSR) to evaluate closeness of original covariance matrix to reproduced covariance matrix. GFI, AGFI and RMSR base on differences between observed (original) and model implied (reproduced) covariance matrix. The GFI was 0.95 and AGFI is 0.94 suggesting a very good fit of the model to the data. RMSR was 0.03 indicating that the average correlation remaining after controlling for predicted relationship was quite small. Moreover, the t-ratios for the specific path coefficients indicated all paths were significant at the $p < 0.01$. Thus, all indicators suggested an overall fit between the model and the observed data.

4.2 Testing the Hypothesis

Following hypotheses were stated in order to test the problems:

1. There is a reciprocal relationship between ATM and AIM.
2. There is a significant effect of father quality on ATM
3. There is a significant effect of father quality on AIM
4. There is a significant effect of mother quality on ATM
5. There is a significant effect of mother quality onAIM
6. There is a significant effect of teacher quality on ATM
7. There is a significant effect of teacher quality on AIM.

They were tested at the level of significance $\alpha = 0.01$

According to the figure 4.1, the two predicted latent variables, AIM and ATM were confirmed and that further more they were found to account for the observed variances and covariances of the manifest variables. Six of the seven attitudinal variables were positively and significantly loaded on latent ATM, conf ($\lambda_y = 0.96$ $p < 0.01$), anx ($\lambda_y = 0.94$ $p < 0.01$), use ($\lambda_y = 0.93$ $p < 0.01$), efmo ($\lambda_y = 0.89$ $p < 0.01$), success ($\lambda_y = 0.80$ $p < 0.01$), imp ($\lambda_y = 0.68$ $p < 0.01$) while maledo ($\lambda_y = -4.58$ $p < 0.01$) negatively and significantly loaded on ATM. Of these seven variables conf accounted for the greatest variance ($R^2 = 0.91$) of latent dependent variable ATM. With respect to the achievement, it was confirmed that achv and maledo were significantly and positively loaded ($\lambda_y = 0.63$, $\lambda_y = 0.80$ $p < 0.01$) on the latent dependent variable AIM. Percieved teacher chatacteristics related to student and profession were significantly and positively loaded ($\lambda_x = 0.89$, $\lambda_x = 0.75$ $p < 0.01$) on the latent variable Teacher Quality. Father Quality was significantly and positively accounted by fathedl ($\lambda_x = 0.27$ $p < 0.01$) and fathexp ($\lambda_x = 0.92$ $p < 0.01$). Mother Quality was significantly and positively accounted by mothedl ($\lambda_x = 0.31$ $p < 0.01$) and mothexp ($\lambda_x = 0.91$ $p < 0.01$). Thus, the first stage in the model evaluation was achieved.

The results shown in Figure 4.1 further show Teacher Quality have a positive direct effect on both ATM ($\Gamma = 0.06$ $p < 0.01$) and AIM ($\Gamma = 0.15$ $p < 0.01$). The indirect effect of Teacher Quality on ATM is larger than its direct effect but indirect effect of TEACHER on AIM is smaller than its direct effect ($IDTQATM = \gamma_{TQAIM} \times \beta_{AIMATM}$, $IDTQATM = 0.15 \times 0.85 = 0.13$; $IDTQAIM = \gamma_{TQATM} \times \beta_{ATMAIM}$, $IDTQAIM = 0.06 \times 0.69 = 0.04$).

However, when calculating the total effect by adding direct and indirect effect of Teacher Quality on AIM and ATM it was found that they are identical in its magnitude ($TOTALTQATM = DETQATM + IDTQATM$, $TOTALTQATM = 0.06 + 0.13 = 0.19$ $TOTALTQAIM = DETQAIM + IDTQAIM$, $TOTALTQAIM = 0.15 + 0.04 = 0.19$ respectively).

Moreover, Father Quality has a positive direct effect on both ATM ($\gamma = 0.06$) and AIM ($\gamma = 0.03$). The indirect effect of Father Quality on ATM and AIM indicates that the direct effect of Father Quality on ATM is larger than its indirect effect while direct effect of Father Quality on AIM is smaller than its indirect effect (IDFQATM $= \Gamma_{FQAIM} \times \beta_{AIMATM}$, IDFQATM = 0.03 × 0.85 = 0.025; IDFQAIM = $\Gamma_{FQATM} \times \beta_{ATMAIM}$, IDFQAIM = 0.06 × 0.69 = 0.04).

However, when calculating the total effect of Father Quality on ATM and AIM, it was found that the effect of Father Quality is identical in its magnitude (FQTALTQATM = DEFQATM + IDFQATM , TOTALFQATM = 0.06 + 0.03 = 0.09 TOTALFQAIM = DEFQAIM + IDFQAIM , TOTALFQAIM = 0.03 + 0.04 = 0.09 respectively)

As predicted Mother Quality has a positive direct effect on AIM ($\beta = 0.09$). However, contrary to prediction, the combined parameter estimate of the effect of Mother Quality on ATM suggests that Mother Quality has a direct negative effect on ATM ($\beta = -0.02$ $p < 0.01$). When the indirect effect is added to the direct effect, pattern is changed namely that Mother Quality has a total positive effect on ATM (TOTALMQATM = DEMQATM + IDMQATM , TOTALMQATM = -0.02 + 0.08 = 0.06 and total positive effect on AIM (TOTALMQAIM = DEMQAIM + IDMQAIM , TOTALMQAIM = 0.09 + -0.01 = 0.07).

Finally, as predicted, reciprocal relationship between ATM and AIM was found. The parameter estimates in Figure 4.1 shows that, as predicted, ATM positively effect on AIM ($\beta = 0.69$, $p < 0.01$) and at the same time AIM has a positive effect on ATM ($\beta = 0.85$, $p < 0.01$). It should be noted that reciprocal effects that ATM and AIM had on one another were different in their magnitude. AIM was found to have a stronger effect on ATM than vice versa.

CHAPTER 5

DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

This chapter includes discussion and interpretation of the findings reported in the previous chapter and implications for further research studies. In the discussion researcher will also combine her own observation with the interpretation of the results .

5.1 Discussion

The results of this study support the hypothesis that a causal model exists for attitudes toward mathematics (ATM), achievement in mathematics (AIM), teacher, mother and father quality. The results show that, as predicted teacher and father have positive direct effect on both ATM and AIM. Furthermore, as predicted, reciprocal relationship was found between ATM and AIM. However, contrary to the prediction mother was found to have negative effect on ATM, but as predicted it has positive effect on AIM.

The relationship between ATM and AIM has often been the subject of inquiry. While some studies demonstrated that the ATM and AIM correlations is quite low ranging from zero to 0.25 in absolute value (Abrego, 1966; Wolf & Blixt, 1981), the others concluded that the strong relationship between ATM and AIM with correlations above 0.40 (Aiken, 1971&1976; Kloosteman, 1981; Randhava &

Beamer, 1982; Minato & Yenase, 1984). Also, there are other studies that examined the causal relationship between ATM and AIM (Enemark & Wise, 1981; Steinkamp, 1982; Mcleod, 1992; Revicki, 1982; Feather, 1988).

However they specified relationship between ATM and AIM as unilateral, disregarding the fact that a unilateral relationship can not capture the interactive characteristic of ATM and

AIM. On the other hand, Ma (1997) studied on the reciprocal relationship between ATM and AIM by using structural equation modelling. He found that reciprocal relationship existed between ATM and AIM. That means attitudes affect achievement and achievement inturn affects attitudes. Result of the present study consistent with the Ma's (1997) study such that reciprocal relationship between ATM and AIM was found. ATM was found to have a significant positive effect on AIM suggesting that the more positive attitudes toward mathematics is associated with higher achievement in mathematics. Affect of AIM on ATM was also found as significant positive suggesting that higher achievement in mathematics associated with more positive attitudes toward mathematics. This result of the present study also coincides with Bloom's Theory of School Learning (see in Theoretical Background Section). In his theory there is a close cycle between students' attitudes and achievement like in the present study.

The result of the present study about effect of teacher, father and mother on ATM and AIM contradicts with the research studies and theoretical background reviewed in the present study. Research studies and theoretical background indicated that effect of teacher, father, and mother on ATM and AIM was positive and significant. In the present study, researcher also found statistically significant effect of teacher, father, and mother on ATM and AIM but they were not practically significant. Since sample size was big path coefficients were significant but they have no practical meaning.

Changing values in our culture, characteristics of the age group and teachers opinions about their profession can be causes of negligible teacher, father and mother effect on ATM and AIM.

It is known that adolescence starts at grade 6. And it never ends, it is continuous process. In this process, it was observed that person tries to prove oneself. Therefore, doesn't want to listen any person, frequently adolescent refuse to listen his / her mother, father and teacher, and refuse to obey rules. He / she doesn't care any of the things that his / her mother / father / teacher wants. Since subjects of the present study are also in this process, this may have resulted in low effect of teacher, father, and mother on ATM and AIM.

Besides adolescence process, it is observed that nowadays parents didn't have time to be interested in their child. They don't care what their child does. There was no encouragement to be good at in the school. They haven't got expectations about their child's achievement. They know little or nothing about child ability. Therefore subjects of the present study may not know their father and mother's attitudes toward them as a learner. This may have resulted in low father and mother effect on ATM and AIM.

Moreover, teacher's points of view may resulted in negligible effect of teacher on ATM and AIM. It is observed that when compared with the past today much more teacher thought that "give lesson and go", they dodn't care students, they dodn't have any expectations from child and his / her job. So he / she dodn't care how much his / her teaching is effective, how students are learning. In other words, wether their students are learning or not is not important for him / her.

In conclusion it can be said that practically low effect of teacher quality, father quality and mother quality on that of ATM and AIM may be because of adolescence process, because of uninterested parents, and because of teachers approach to being teacher. and teaching.

Six of the seven attitudinal variables, success attribution in mathematics, confidence in learning mathematics, math-anxiety, effectance motivation, usefulness of mathematics and importance of mathematics were positively and significantly loaded on latent dependent variable ATM.

Confidence in learning mathematics positively and significantly loaded ($\beta = 0.96$, $p < 0.01$) on ATM.In otherwords, more confident student is associated with more positive attitudes toward mathematics and more positive attitudes toward mathematics is associated with higher achievement in mathematics. This result is consistent with the Ecceles and his colegues (1983) Achievement Behaviour Model. In the model confidence in learning mathematics that is ones ability to learn and perform well on mathematical tasks is directly influence achievement behaviours. Ethington (1992) identified direct influence of self-concept on achievement. Moreover, Fennema and Sherman (1977,1978) found that positive correlations between mathematics achievement and confidence measured by the Fennema and Sherman Confidence in Learning Mathematics Scale. However, this finding of the present study is inconsistent with the finding of the Bulut's (1988) study. She did not find significant relationship between mathematics self-concept and mathematics achievement.

Usefulness of mathematics positively and significantly loaded ($\beta = 0.93$, $p < 0.05$) on ATM suggesting that the more student believed mathematics is useful in relationship to their future education and vocation is associated with more positive attitudes toward mathematics and more positive attitudes toward mathematics is associated with higher achievement in mathematics. This finding consistent with Atkinson's (1964) Expectancy X Value Model of Achievement Motivation that is strong perception of mathematics is useful, and therefore valuable, will result in the motivation to continue. Carpenter and Corbit (1980) also found that students percieved math as the useful to themselves as individuals. Pedro, Wolleat, Fennema and Becker (1981) identified usefulness was the strongest predictors of plans to study high school mathematics. Lantz and Smith (1981) found that the subjective value placed on mathematics was the attitudinal variable most highly correlated with mathematics participation.

Mathematics anxiety is positively and significantly loaded ($\beta = 0.94$, $p < 0.01$) on ATM that is low mathematics anxiety contributes positive attitudes toward mathematics and positive attitudes toward mathematics is associated with higher achievement. High mathematics anxiety contributes negative attitudes and negative attitudes toward mathematics are associated with low achievement. This finding is consistent with the findings of the studies of Aiken (1970,1976), Fennema (1977), Fax (1977), Betz (1978); Holden (1987) that is mathematics anxiety contributes to mathematics avoidance and poor mathematics performance.

Success attribution in mathematics is loaded positively and significantly

($\beta = 0.80$, $p < 0.01$) on ATM suggesting that the more students attribute their success to their ability and failure to effort and luck is associated with the more positive attitudes toward mathematics and the more positive attitudes toward mathematics is associated with higher achievement in mathematics. This result of the study is consistent with the Weiners (1974) Attribution of Success and Failure Theory. TIMSS (1997) also identified that success attribution was an important attitudinal factor.

Importance of mathematics is significantly and positively loaded ($\beta = 0.68$, $p < 0.01$) on ATM. In otherwords, the more students aware of importance of mathematics is associated with higher achievement in mathematics. This finding consisted with TIMSS (1997) results that is importance of mathematics was the important attitudinal variable. Ma (1997) also identified importance of mathematics was a kind of awareness or recognition, an attitudinal element that encourage students to put more effort into learning mathematics.

The last attitudinal variable that significantly and positively loaded on ATM is effectance motivation ($\beta = 0.89$, $p < 0.01$). In other words, the more students involved in mathematics and enjoyed with mathematics is associated with the more positive attitudes toward mathematics and the more positive attitudes toward mathematics is associated with higher achievement in mathematics. Ma (1997), for example, reported that enjoy with mathematics was an important attitudinal variable, and feeling of enjoyment directly effect attitudes toward mathematics. TIMSS (1997) also identified that enjoy with mathematics was an important attitudinal variable and it was positively and significantly loaded on attitudes toward mathematics.

Of the seven-attitudinal variables contributing to the latent independent variable ATM, mathematics as male domain is negatively and significantly loaded. However, it is loaded positively and significantly on AIM. This results of the study means that when a student thought that mathematics is much more appropriate area for boys than girls to study than he / she develops negative attitudes toward mathematics and getting high achievement in mathematics. Since in the present study researcher didn't develop model for boys and girls separately, this result doesn't says there is a gender differences or there is no gender differences. It says only for all students when they believe that mathematics is a boy dominated area they develop negative attitudes toward mathematics and being more successful.

However, it is observed that when girls think mathematics is much more appropriate to boys than girls then they are developing negative attitudes toward mathematics and to show themselves in mathematics they are studying a lot and this brings high achievement. When boys think mathematics is much more appropriate to himself than girls then they are developing positive attitudes toward mathematics and to show mathematics is really much more appropriate area to study for boys they are studying a lot which brings high achievement in mathematics. Nevertheless to say there is a gender difference separate models have to be developed for boys and girls.

5.2 Implications

In this section, the implications of the present research can be stated as follows:

- Teacher should be recognise and overcome the problem of negative attitudes toward mathematics and instructional consequences of these attitudes.

- Teacher should be aware of the problems of anxious students. She/he should be focus on causes, effects and remedies of mathematics anxiety.

- Teacher should be create such a classroom environment that students have to be sure about their ability to learn new topics in mathematics and perform well in mathematics class.

- Teacher should be aware of the causes of success and failure of the students' achievements and should talk with the students bout causses of their success and failure.

- Teacher should be aware of the students perception of usefulness and importance of mathematics. She/he should provide a classroom environment that students see the usefulness and importance of mathematics in the daily life and in the future vocation.

- Teacher should behave equally and encourage equally both boys and girls to study mathematics.

- Those more positive attitudes toward mathematics results in higher achievement in mathematics. Thus, teacher should be careful about the attitudes toward mathematics of their students developed. Teacher should create different classroom settings so that student can see different teaching method of mathematics and can actively engage in learning process. Teacher should provide that students see mathematics from different perspective.

- Parents should be cooperate with teachers, encourage their child and confident their child ability.

5.3 Recommendations for Further Research

Followings are some recommendations for further research on the reciprocal relationship between attitudes toward mathematics (ATM) and achievement in mathematics (AIM):

- The sample size can be increased in further studies.

- The researcher can carry out further research on reciprocal relationship between ATM and AIM including father and mother occupations .

- The researcher can carry out further reassert on reciprocal relationship between ATM and AIM for boys and girls separately.

- The researcher can carry out further research on reciprocal relationship between ATM and AIM including culture as a variable in the model.

- The researcher can carry out further research on reciprocal relationship between ATM and AIM including school type as a variable.

- The researcher can carry out further research on reciprocal relationship between ATM and AIM developing different models.

REFERENCES

Aiken, L.R. (1971). Attitudes toward Mathematics. *Review of Educational Research,* 40(4), 551-596.

Aiken, L.R. (1972). Research on Attitudes toward Mathematics. *The Arithmetic Teacher,* 19, 229-234.

Aiken, L.R. (1976). Update on Attitudes and other Affective Variables in Learning Mathematics. *Review of Educational Research,* 46, (2), 293-311.

Aiken, L.R. (1976). Update on Attitudes and Other Affective Variables in Learning Mathematics. *Review of Educational Research*, 46(2), 293-311.

Aksu, M. & Saygı, M. (1988). The Effects of Feedback Treatment on Mathematics Anxiety Levels of 6 Grade Turkish Students. *School Science and Mathematics*, 88(5), 390-396.

Austin, S. & Wadlington, E. (1992). Effect of Beliefs about Mathematics on Math Anxiety and Math Self Concept in Elementary Teachers. *Education* 112(3), 390-404 .

Bentler, P.M. (1980). Multivariate Analysis with Latent Variables: Causal Modelling. *Annual Review of Psychology*, 31, 419-456.

Berberoğlu, G. (1995). Differential Item Functioning Analysis of Computation, Word Problem and Geometric Questions across Gender and SES Groups. *Studies in Educational Evaluation,* 21, 439-456.

Berberoglu, G. and Demircioglu, H. (in press). Factors Affecting Achievement in General Chemistry Courses among Science Major Students. Egitim Ve Bilim.

Beberoglu, G. (1999). Fizik Egitiminde Kazanilmasi Gereken Zihinsel Beceriler ve Bazi oneriler. Turk Fizik vakfi sempozyumu-99: Okullarda Fen/fizik Ogrteiminde Olcme Degerlendirme

Berberoglu, G. & Tosunoglu, C. (1995). Explatory and Confirmatory Factor Analyses of an Environmental Attitude Scale (EAS) for Turkish University Students. *Journal of Environmental Education,* 26, 40-43.

Bos, K.T. & Kuiper, W. (1999). Modelling TIMSS Data in an European Comparative Perspective: Exploring Influencing Factor on Achievement in Mathematics in Grade 8. *Educational Research and Evaluation,* 5.2.

Bulut, S. (1988). Relationship Between Mathematics Self-Concept and Some Related Characteristics of Mathematics Education Turkish Freshmen at METU. Master Thesis, Middle East Technical University, Ankara, Turkey.

Carpenter, T.P., Corbitt, K.M., Kepner, H.S., Lindguist, M.M. & Reys, R. (1980). Students' Affective responses to Mathematics: Results and Implications from National Assesment. *Arithmetic Teacher* October, 34-52.

Carter, G. & Narwood, K. (1997). The Relationship Between Teacher and Student Beliefs about Mathematics. *School Science and Mathematics,* 97 (2) 62-67.

Casey, M.B., Nuttall, R.L. & Pezaris, E. (1997). Mediators of Gender Differences in Mathematics College Entrance Test Scores: A Comparison of Spatial Skills with Internalised Beliefs and Anxieties. *Developmental Psychology,* 33(4), 669-680.

Cheung, K.C. (1988). Outcomes of Schooling: Mathematics Achievement and Attitudes towards Mathematics Learning in Hon Kong. School *Science and Mathematics*, 19, 209-219.

Corbit, M. (1984). When Students Talk ... *Arithmetic Teacher,* 16-20.

Martha, F.L. (1990). What Myths About Mathematics are Held and Conveyed by Teachers? *Arithmetic Teacher* 25-29 .

Dungan, J.F. & Thurlow, G.R. (1989). Students' attitudes to Mathematics: A Review of the Literature. *The Australian Mathematics Teacher*, 45,(2) 8-11.

Enemark, P. & Wise, L.N. (1991). Supplementary Mathematics Probe Study Final Report. *Unpublished Manuscript. American Institute for Research in the behavirol Sciences, Palo Alto, CA..*

Erktin, E. (1994). Matematik Korkusu. In İ.Akhun, İlköğretim Okullarında Matematik Öğretimi ve Sorunları. Türk Eğitim Derneği XII. Öğretim Toplantısı, 12-13 Mayıs, 141-157.]

Ethington, C.A. & Wolfle, L.M. (1986). A Structural Model of Mathematics Achievement for Men and Women. *American Educational Research Journal*, 23, 65-75.

Ethington, C.A. (1992). Gender Differences in a Psychological Model of Mathematics Achievement. *Journal for Research in Mathematics, Education* 23(2), 166-181.

Ethington, C.A. , Wolfle, L.M. (1986). A Structural Model of Mathematics Achievement for Men and Women. *American Education Research Journal*, 23, 65-75.

Feather, N.T.. (1988) Values, Valences, and Course Enrollment: Testing the Role of Personal Values within and Expectancy-Value Framework. *Journal of Educational Psychology*, 80, 381-391.

Fennema, E., Carpenter, T.P. (1981) Sex-Related Differences in Mathematics: Results from National Assessment. *Mathematics Teacher,* 74(7), 554-559.

Fennema, E., Peterson, P.L., Carpenter, T.P., Lubinski, C.A. (1990) Teachers' Attributions and Beiefs about Girls, Boys, and Mathematics *Educational Studies in Mathematics,* 21, 65-69.

Fennema, E., Sherman, J.(1976). Fennema-Sherman Mathematics Attitude Scales Instrument Designed to Measure Attitudes toward the Learning of Mathematics by Females and Males. *JSAS Catalogue of Selected Documents in Psychology.*

Fleener, J.M. (1996). Scientific World Building on the Edge of Chaos: High School Students' Beliefs About Mathematics and Science. *School Science and Mathematics,* 96(6), 312-321.

Frankell, J.R. & Wallen, N.E. (1996). How to Design and Evaluate Research in Education. *New York, McGrow-Hill, Inc.*

Fung L.Y. (1993). Attitude Toward Mathematics and Science of African-American, Mexican-American Middle Grade Students Identified as Gifted. *Focus on Learning Problems in Mathematics Winter Edition*, 15, (1).

Gabrielle, K. , Gabrielle, M. (1993). Results of an Empirical Study into Gender Differences in Attitudes Towards Mathematics. *Educational Research in Mathematics,* 25, 209-233.

Garofalo, J. (1989). Beliefs and Their Influence on Mathematical Performance. *Mathematics Teacher,* October 502-505.

Gwizdala, J. & Steinback, (1988). M. Gender Differences in Mathematics Attitudes of Secondary Students. *School Science and Mathematics*, 95(1), 36-41.

Haladyna, T., Shaughnessy, J., & Shaughnessy, J.M. (1983). A Causual Analysis ofAttitude Toward Mathematics. *Journal for Research in Mathematics Education*, 14 (1), 19-29.

Hall, C.W. & Hoff, C. (1988). Gender Differences in Mathematical Performance *Educational Studies in Mathematics,* 19, 395-401.

Hanna, G. (1986). Sex Differences in the Mathematics Achievement of Eight Grades in Ontorio. *Jornal for Research in Mathematics,* 17, 231-237.

Hanna, G. (199). Mathematics Achievement of Girls and Boys in Grade Eight: results from Twenty Countries. *Educational Studies in Mathematics,* 20, 225-232.

Hilton, T.L. Berglund, W.G. (1982). Sex Differences in Mathematics Achievment-A Longitudinal Study. *The Journal of Educational Research*, 231-237.

Hyde, J.S., Fennema, E. and Lamon, S.J. (1990). Gender Differences in Mathematics Performance: A Meta-Analysis. *Psychological Bulletin*, 107, 139-155.

Karp, S., (1991). Elementary School Teachers Attitudes Toward Mathematics: The Impact on Students' Autonomous Learning Skills.*School Science and Mathematics,* 91(6) 265-269

Kloosterman, P. (1981) Beliefs and Achievement in Seventh-Grade Mathematics. *Focus on Learning Problems in Mathematics*, 13(3), 3-15.

Levine, T. & Schmidt,S. (1997). Commitment to Learning: Effects of Computer Experience, Confidence and Attitudes. *Journal of Educational Computing Research*, 16(1) 83-105.

Lewis, R. & Aiken, J.R (1970). Nonintellective variables and Mathematics Achievement: Directions for Research, *Journal of School Psychology* 8(1), 28-37.

Ma, X. (1997). Reciprocal Relationship between Attitude toward Mathematics and Achievement in Mathematics. *The Journal of Educational Research,* 90 (4) 221-229.

Ma, X. (1999). A Meta-Analysis of the Relationship Between Anxiety Toward Mathematics and Achievement in Mathematics. *JRME Online: Issues: November* 520-540.

Ma, X. & Kishor, N. (1997). Assessing the Relationship between Attitude toward Mathematics and Achievement in Mathematics: A Meta-Analysis. *Journal for Research in Mathematics Education*, 28, 26-47.

Marsh, H.W., Parker, J.W. & Simith, I.D. (1983). Preadolescent Self Concept: Its Relationship to Self Concept as Inferred by Teachers and to Academic Ability. *British Journal of Educational Psychology*, 53, 60-78.

McLeod, D.B (1992). Research on Affect in Mathematics education: A Reconceptualization. *Hand Book of Research on Mathematics Teaching and Learning* 575-576.

McLeod, D.B. (1992). Research on Affect in Mathematics Education: Reconceptualization. In D.A. Grouws (Ed). *Handbook on Mathematics Teaching and Learning, New York: Macmillan Comp.* 575-596

Pedro, D., Woleat, P., Fennema, E. & Becker, D. (1981). Election of High School Mathematics by Females and Males: Attributions and Attitudes. *American Educational Research Journal,* 18, 207-218

Quin, D.W. & Jadow, A.D. (1987). Casual Relationship between Attitude and Achievement for Elementary Grade Mathematics and Reading. *Journal of Educational Research*, 80, 366-372.

Relich, J. & Way, J. (????). Measuring Pre-Service Teachers Attitudes to Mathematics: Further Developments of a Questionnaire. *Psychology of Mathematics Education,* 4 105-111.

Reyes, H. L. (1984). Affective Variables and Mathematics Education. *The Elementary School Journal,* 84(5), 538-581.

Schibeci, R.A. (1989). Home, School, and Peer Group Influences on Students Attitudes and Achievement in Science. *Science Education*, 73(1), 13-24.

Schibeci, R.A. & Riley, J.P. (1986). Influence of Students' Background and Perceptions an Science Attitudes and Achievement. *Journal of Science in Teaching,* 23(3), 177-187.

Schiefele, U. & Csikszentmihalyi, M. (1995). Motivation and Ability as Factors in Mathematics Experience and Achievement. *Journal for Research in Mathematics Education,* 26(2), 163-181.

Schmidt, W.H. (1983). High School Course Taking: its Relationship to Achievement.*Journal of Curriculum Studies,* 15(3), 311-332.

Schumer, R.E. (1996). A Biggener's Guide to Structrual Equation Modeling. *Mahwan, NJ: L. Erlbaum Associates.*

Song, I. & Hattie, J. (1984). Home Environment, Self-Concept, and Academic Achievement: A Casual Modelling Approach. *Journal of Educational Psychology*, 76(6), 1269-1281.

Southwell, B. & Khamis, M. (1980). Affective Constraints in Mathematics Education. *Psychology of Mathematics Education,* 4, 267-74.

Steele, F.D. & Widman, F.T. (1997). Practitioner's Research: A Study in Changing Presevice Teachers' Conceptions About Mathematics and Mathematics Teaching and Learning. *School Science and Mathematics,* 97, (4) 184-190.

Süleymenoğlu, K.A.R, (1997) A Path Analytic Study for English Language Attitude, and Students Background Characteristics in an ELT Program: A Case Study. Master Thesis, Middle East Thecnical University, Ankara , Turkey.

Tsai, L. & Walberg, H.J. (1983). Mathematics Achievement and Attitude Productivity in Junior High School. *Journal of Educational Research,* 76(5), 267-272.

Tosunoğlu, C. (1993) A study of the dimesions and determinants of environmental attitudes Phd Theis Middle East Technical University, Ankara, Turkey

Vanayan, M., White, N., Yuen, P. & Teper, M. (1997). Beliefs and Attitudes Toward Mathematics among Third and Fifth Grade Students: A Descriptive Study. *School Science and Mathematics,* 97 (7) 345-351 40, (4), 551-596.

Wang, J., Wildman, L. & Calhoun, G. (1996). The Relationship between Parental Influence and Student Achievement in 7th Grade. Mathematics *School Science and Mathematics*, 96(8).

Welch, W.W., Anderson, R.E. & Harris, L.J. (1982). the Effects of Schooling on Mathematics Achievement. *American Educational Research Journal,* 19(1), 145-153.

Wolf, F.M. & Blixt, S.L. (1981). A Cross-sectional cross-lagged analysis of Mathematics Achievement and Attitudes: Implications for the interpretation of the Direction of Predictive Validity. *Educational and Psychological Measurement,* 41, 829-834.

Wolfok, A.E. (1993). Motivation and the Individual Learner. *Educational Psychology, Allyen &Bacon Company*, Boston.

APPENDICES

APPENDIX A

MATEMATİK TESTİ

Yönerge: Bu testte toplam 20 soru bulunmaktadır. Lütfen soruları dikkatli okuduktan sonra cevabı işaretleyiniz. Bu test sadece araştırma amacıyla kullanılacaktır. Ve verdiginiz cevaplar kesinlikle gizli tutulacaktır. Yardımlarınız için çok teşekkürler !!!

1) A= { {1,2}, {2,3}, {1}, {2}} kümesi veriliyor. Bu kümenin alt kümelerinden biri aşağıdakilerden hangisidir?

a) { 1 } **b)** { {1,2,3}, {1} } **c)** { 2 } **d)** { { 2,3}, {1,2 }}

2) 10 – [2 . (7 – 4) – (2 + 4) : 3]

a) 6 **b)** 5 **c)** – 7 **d)** – 8

3) $\dfrac{5}{8} - \dfrac{\dfrac{1}{2} - \dfrac{1}{3} + \dfrac{1}{12}}{\dfrac{1}{2} + \dfrac{1}{3} - \dfrac{1}{6}}$ işleminin sonucu kaçtır?

a) 4 **b)** $\dfrac{11}{22}$ **c)** $\dfrac{1}{2}$ **d)** $\dfrac{1}{4}$

4) $\dfrac{(-1)^{601} . (-1)^{444} + (-1)^{2001}}{(-1)^{1001} . (-1)^{100}}$ işleminin sonucu kaçtır?

a) – 2 **b)** 2 **c)** 1 **d)** – 1

5) $\dfrac{\sqrt{0,16} + \sqrt{2,25}}{\sqrt{0,25} + \sqrt{1,44}} + \dfrac{\sqrt{1,21}}{\sqrt{2,89}} = a$ işleminin sonucu kaçtır?

a) $\dfrac{17}{5}$ **b)** $\dfrac{13}{5}$ **c)** $\dfrac{30}{17}$ **d)** $\dfrac{15}{17}$

6) $\left(\dfrac{a^2 - 9}{a + 4} \cdot \dfrac{a^2 - 16}{a - 3}\right) : \dfrac{a^2 + 3a}{a}$ ifadesinin sadeleşmiş şekli nedir?

a) a + 2 **b)** a – 3 **c)** 2a + 3 **d)** a – 4

7) Bir mal "x" lira karla 120.000 liraya, aynı mal "y" lira zararla 105.000 liraya satılıyor. "x" ile "y" arasındaki bağıntı aşağıdakilerden hangisidir?

a) x –y = 10.000 **b)** x – y = 15.000 **c)** x + y = 15.000 **d)** x + y = 10.000

8) Bir sınıftaki sıralara öğrenciler üçer otururlarsa 9 kişi, ikişer kişi oturularsa 14 kişi ayakta kalıyor. Buna göre sınıfta kaç sıra vardır?

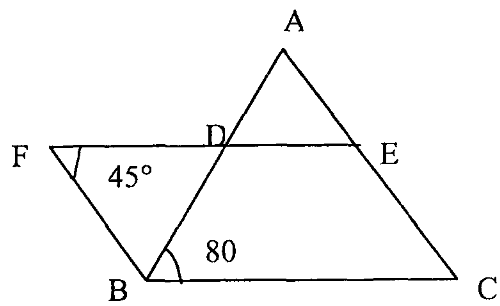
a) 15 **b)** 5 **c)** 7 **d)** 23

9) Bir baba oğlundan 30 yaş büyüktür. 4 yıl sonra yaşlarının oranı 3 olacaktır. Şimdi oğlu kaç yaşındadır?

a) 11 **b)** 13 **c)** 20 **d)** 15

10) Şekilde, BFD açısı'nın ölçüsü 45 derece, ABC açısı'nın ölçüsü 80 derecedir. [FE], [BC]'ye paraleldir. O halde, FBD açısı'nın ölçüsü kaç derecedir?

a) 50 **b)** 60 **c)** 55 **d)** 45

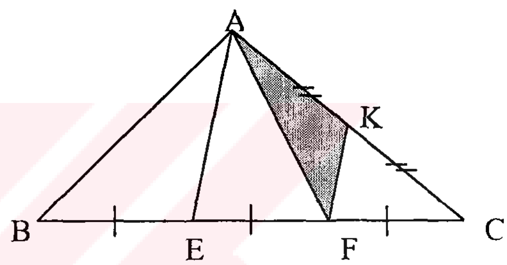


11) Yandaki ABC üçgeninde,

| BE | = | EF | = | FC |

ve | AK | =| KC |'dir.

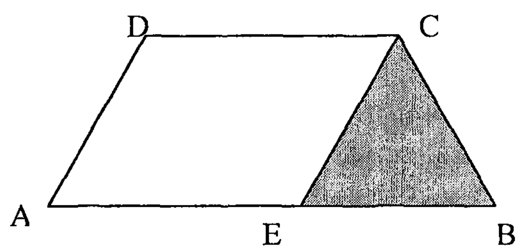
Bunlara ek olarak, taralı üçgenin alanı 12 cm^2'dir. O halde, ABC üçgeninin alanı kaç cm^2'dir.



a) 72 **b)** 64 **c)** 48 **d)** 36

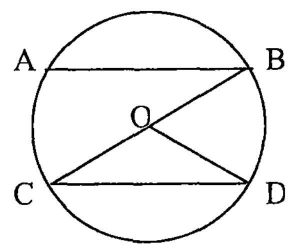
12) Yandaki şekilde | EB | = 8 cm, | AE | = | DC | = 6 cm'dir. Bunlara ek olarak, EBC üçgeninin alanı 16 cm^2'dir.

O halde, ABCD yamuğunun alanı kaç cm^2'dir.



a) 32 **b)** 36 **c)** 48 **d)** 40

13) Şekilde A, B, C ve D noktaları "O" merkezli çember üzerindedir. [AB], [CD]'ye paraleldir. ABC açısı'nın ölçüsü 30° ise COD açısı'nın ölçüsü kaç derecedir?



a) 100 b) 110 c) 120 d) 130

14) $\frac{\sin 30^\circ \cdot \cos 60^\circ}{2 \tan 45^\circ}$ ifadesinin değeri aşağıdakilerden hangisidir?

a) $\frac{1}{2}$ b) $\frac{1}{8}$ c) 2 d) $\frac{1}{16}$

15) Bir dik üçgende $\tan x = \frac{4}{3}$ ise $\frac{1}{\cos^2 x + 1}$ aşağıdakilerden hangisidir? (Not: "x" açısının ölçüsü 90°'den küçüktür).

a) $\frac{25}{34}$ b) $\frac{25}{41}$ c) $\frac{16}{25}$ d) $\frac{9}{25}$

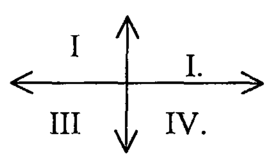
16) K (1, – 4) noktası, aşağıdaki doğrulardan hangisinin üzerindedir?

a) y= 2x + 6 b) y=3x + 9 c) y=4x – 8 d) y=5x – 10

17) $y = \frac{-4}{5} x \times 1$ doğrusuna aşağıdaki doğrulardan hangisi paraleldir?

a) $y = \frac{4}{5}x + 1$ b) $\frac{-4}{5}$ y= x+1 c) $y = \frac{-5}{4}x + 1$ d) $y + \frac{4}{5}x + 1 = 0$

18) Şekilde x < 0 ve y > 0 şartını birlikte sağlayan (x,y) noktalarının kümesi, hangi bölgede bulunur?



a) I. Bölge b) II. Bölge c) III. Bölge d) IV. Bölge

19) {0, 1, 2, 3, 4, 5} kümesinin elemanları ile rakamları farklı, 300'den büyük 5'in katı olan, 3 basamaklı, kaç tek sayı yazılabilir?

a) 8 **b)** 7 **c)** 30 **d)** 50

20) Bir zar ve bir para atıldığında, zarın "3" ve paranın "yazı" gelme olasılığı kaçtır?

a) $\frac{2}{3}$ **b)** $\frac{1}{72}$ **c)** $\frac{1}{36}$ **d)** $\frac{1}{12}$

APPENDIX B

Table B.1 Table of Specification for Mathematics Achievement Test

Objectives / Contents	Comprehension	Application
Sets	1	2
Real Numbers	3, 4	
Exponential Numbers	5	
Radicals	6	
Factorization	7	
Word Problems		8, 9, 10, 11
Angles	12	
Triangles		13,14,15,18
Circles		16, 17
Trigonometry	19, 20	
Coordinate systems and Line Equation		24
Permutation		25
Probability		23

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ