HIGH SCHOOL STUDENTS' BELIEFS ABOUT MATHEMATICS AND THE TEACHING OF MATHEMATICS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

ÖZGE MERT

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
SECONDARY SCIENCE AND MATHEMATICS EDUCATION

AUGUST 2004

Approval of the Graduate School of Natural and Applied Sciences

Prof. Dr. Canan ÖZGEN
Director

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

Prof. Dr. Ömer GEBAN
Head of Department

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

Assoc. Prof. Dr. Safure BULUT
Supervisor

Examining Committee Members

Prof. Dr. Ömer GEBAN (METU,SSME)

Assoc. Prof. Dr. Safure BULUT (METU,SSME)

Assoc. Prof. Dr. Ahmet ARIKAN (GAZİ U.,SSME)

Assist.Prof. Dr. Cennet Engin DEMİR (METU,EDS)

Dr. Hasan KARAASLAN (METU,CEIT)

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name : Özge Mert

Signature :

ABSTRACT

HIGH SCHOOL STUDENTS' BELIEFS
ABOUT MATHEMATICS AND THE TEACHING OF MATHEMATICS

Mert, Özge
M.S., Department of Secondary Science and Mathematics Education
Supervisor: Assoc. Prof. Dr. Safure Bulut

August 2004, 96 pages

The purpose of the study was to investigate the high school students' beliefs about mathematics and the teaching of mathematics. The study was conducted in Ankara with 425 tenth-grade students enrolled to general, Anatolian, foreign language, and vocational high schools. Two measuring instruments were utilized: 1. Beliefs about mathematics Scale (BaMS); 2. Beliefs about the Teaching of Mathematics Scale (BTMS). The validity and reliability of these scales were tested. The design of the present research is a casual-comparative study. The hypotheses of the present study were tested by using multivariate analysis of variance at the significance level 0.05.

The results of the study indicated that: 1. There are statistically significant differences among the mean scores of students enrolled to different kinds of high schools with respect to beliefs about mathematics and beliefs about the teaching of mathematics; 2. There are statistically significant mean differences among students who have different mathematics achievement levels in terms of beliefs about mathematics and beliefs about the teaching of mathematics; 3. There are statistically significant mean differences among students who are in the different branches in terms of beliefs about mathematics and the beliefs about the teaching of mathematics; 4. There is no statistically significant mean difference between the male and female students on beliefs about mathematics. On the other hand, there is statistically significant mean difference between the male and female students on beliefs about the teaching of mathematics in the favor of female students.

Key words: Beliefs, Mathematics, Teaching of Mathematics, Gender, High School Students

ÖZ

LİSE ÖĞRENCİLERİNİN
MATEMATİK VE MATEMATİĞİN ÖĞRETİMİ HAKKINDAKİ
İNANÇLARI

Mert, Özge
Yüksek Lisans, Orta Öğretim Fen ve Matematik Alanları Eğitimi Bölümü
Tez Yöneticisi: Doç. Dr. Safure Bulut

Ağustos 2004, 96 sayfa

Bu çalışmanın amacı, lise öğrencilerinin matematik ve matematik öğretimi hakkındaki inançlarını araştırmaktır. Araştırma, Ankara' daki genel, Anadolu, yabancı dil ağırlıklı ve meslek liselerinde kayıtlı bulunan 425 onuncu sınıf öğrencisiyle yürütülmüştür.Bu araştırma için iki ölçme aracı kullanılmıştır: 1. Matematik Hakkındaki İnançlar Ölçeği; 2. Matematiğin Öğretimi İle İlgili İnançlar Ölçeği. Bu araçların geçerlik ve güvenilirlikleri test edilmiştir. Bu araştırmanın deseni nedensel karşılaştırmalı çalışmadır. Bu çalışmanın hipotezleri 0.05 anlamlılık düzeyinde çok yönlü varyans analizi kullanılarak test edilmiştir.

Çalışmanın sonuçları şunları göstermiştir: 1. Matematik ve matematiğin öğretimi ile ilgili inançları açısından farklı liselerde okuyan öğrencilerin ortalamaları arasında istatistiksel olarak anlamlı bir fark bulunmaktadır. 2. Farklı matematik başarı seviyesine sahip lise öğrencilerinin matematik ve matematiğin öğretimi ile ilgili inançları açısından ortalama skorları arsında istatistiksel olarak anlamlı bir fark bulunmaktadır. 3.Farklı branşlarda bulunan lise öğrencilerinin matematik ve matematik öğretimi hakkındaki inançları açısından istatistiksel olarak anlamlı bir fark bulunmaktadır. 4. Matematik ile ilgili inançları açısından kız ve erkek öğrenciler arasında istatistiksel olarak anlamlı bir fark bulunmamaktadır. Öte yandan, matematiğin öğretimi ile ilgili inançları açısından kız ve erkek öğrenciler arasında istatistiksel olarak kız öğrenciler lehine anlamlı bir fark bulunmaktadır.

Anahtar Kelimeler: İnançlar, Matematik, Matematik Öğretimi, Cinsiyet, Lise Öğrencileri

ACKNOWLEDGEMENTS

I wish to express my gratitude to Assoc. Prof. Dr. Safure Bulut for her sincere interest, patience and criticism throughout my study.

I wish to thank my mother, my father and my sister for sharing all the stress with me and encouraging me.

I wish to thank to my all friends for their guidance during the master.

I would like to thank my students who participated in my study and shared their comments and ideas with me.

TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF ABBREVIATIONS

BaMS..............................: Beliefs about Mathematics Scale

BTMS.............................: Beliefs about the Teaching of Mathematics Scale

Highachv........................: High Achiever Students with respect to MathAchvL

Lowachv.........................: Low Achiever Students with respect to MathAchvL

M....................................: Mean

MathAchvL.....................: Mathematics Achievement Level

MANOVA......................: Multivariate Analysis of Variance

Modachv........................: Moderate Achiever Students with respect to MathAchvL

SPSS...............................: Statistical Packages for Social Science

CHAPTER 1

INTRODUCTION

Mathematics is a subject that is needed for everyday life and thus it is a necessary part of the curriculum. Mathematics is also important in many other fields that mathematics should be studied in order to develop logical thinking, creativity and spatial abilities. For this reason more attention must be given to students to understand the importance of mathematics and its applications of daily life.

In response to the question "What is mathematics?", Hersh (1986) explained as:

> *"Mathematics deals with the ideas. Not pencil marks or chalk marks, not physical triangles or physical sets, but ideas (which may be represented or suggested by physical objects)."(p 127)*

Ernest (1989) distinguished three possible conceptions of mathematics that relate to a philosophy of mathematics:

> *"First of all, there is the instrumentalist view that mathematics is an accumulation of facts, rules and skills to be used in the pursuance of some external end. Thus, mathematics is a set of unrelated but utilitarian rules and facts. Secondly, there is the Platonist view of mathematics as a static, but unified body of certain knowledge. Mathematics is discovered not created. Thirdly, there is the problem solving view of mathematics as a dynamic, continually expanding field of human creation and invention, a cultural product. Mathematics is a process of enquiry and coming to know, not a finished product, for its results remain open to revision."(p 21)*

An alternative account of the meaning and nature of mathematics emerges from a sociological analysis of mathematical knowledge. Thompson (1992) stated that mathematicians and philosophers of mathematics depicted mathematics as a kind of mental activity, a social construction involving conjectures, proofs, and refutations, whose results are subject to revolutionary change and whose validity, therefore, must be judged in relation to a social and cultural setting.

But for many people, mathematics is also considered to be difficult to learn. Students usually escape mathematics because of its requiring abstract thinking, creativity, integrating and organizing information. Kloosterman (1999) noted that one of the reasons that affect students' understanding of mathematics is what belief students have about mathematics.

Generally, most students believe that mathematics is an area that it includes exact true or wrong knowledge. Schoenfeld (1989) listed students' typical beliefs about mathematics:

- The problem in mathematics has only one correct answer.
- The most important thing is to find the correct answer of a problem.
- There is only one way to solve the mathematical problem.

Fleener (1996) stated that students had well defined beliefs about (1) the nature and discovery of mathematical and scientific truths, (2) the value and importance of engaging in mathematical and scientific inquiry, (3) equity with respect to gender, and (4) importance of pursuing mathematics and science to careers. On the other hand, Fleener (1996) also stated that their beliefs about the nature of mathematics and technology and their views of the role of science in society were less defined.

The central role of beliefs for the successful learning of mathematics has been pointed out again and again by several educators in mathematics. Pehkonen and Törner (1999) stated that 'beliefs may have a powerful impact on how children will learn and use mathematics, and therefore they may also form an obstacle for the effective learning of mathematics. Pupils who have rigid and negative beliefs of mathematics and its learning easily become passive learners, whose emphasis will be placed more on memorizing than on understanding in the process of learning" (p 5). In addition, Eynde, Corte & Verschaffel (1999) stated that learning students' mathematical beliefs provides understanding the role of emotions in mathematics lessons.

Kloosterman (1999) noted that beliefs are important with respect to motivation to learn mathematics. Issues such as beliefs about oneself as learner, usefulness of mathematics in career, intrinsic beauty of mathematics, and short term rewards such as grades all can play a role in how hard students work in mathematics class. He also stated that the question "what is mathematics?" was difficult for many students to answer, probably because they were never asked to think about the nature of mathematics. Responses to the alien questions as well as other questions throughout his interview indicate that students think that there is a significant procedural aspect to mathematics but most also thinks that some people could be successful without having to memorizing everything. Believing that memory is very important, and believing that people who cannot memorize can still do mathematics is typical of many students comment. Students' beliefs are common and seem to indicate that students are often doing mathematics assignments without thinking about what it takes to learn or why knowing mathematics is important (Kloosterman, 1999).

Similarly, Gonske (2002) also stated that students believed understanding conceptions was important, but also believed most mathematics problems could be solved primarily by memorizing and following an appropriate sequence of steps.

Spangler (1992) stated that "there appears to be a cyclic relationship between beliefs and learning. Students' learning experiences are likely to contribute to their beliefs about what it means to learn mathematics. In turn, students' beliefs about mathematics are likely to influence how they approach new mathematical experiences" (p 19). According to the *Standards*, "Students' beliefs exert a powerful influence on students' evaluation of their own ability, on their willingness to engage in mathematical tasks, and on their ultimate mathematical disposition." (NCTM, 1989, p 233)

Important questions concerning the role of gender in explaining mathematical achievement and behaviors toward mathematics have been researching over years (Vanayan, White, Yuen & Teper, 1997; Stipek and Gralinski, 1991). It has been tried to identify learner related variables such as self-confidence, anxiety, attitudes, beliefs, fear of success and failure where it is believed these variables affect males and females in ways and they are differentiated by gender.

The existing some research studies on gender differences related to beliefs about mathematics shows that there are no significant differences for the beliefs of girls and boys with respect to mathematics (e.g., Baydar, 2000; Aksu, Demir and Sümer, 2002). On the other hand there is another evidence for gender difference that even at young age, boys hold more positive beliefs than girls about their competence in mathematics (e.g. Eccles et al, 1993). Eccles et al (1993) reported that girls and boys valued mathematics equally, but boys were more likely to believe that they were more competent than girls. In addition, boys hold higher competence beliefs in mathematics and sports than girls do, whereas girls often have higher competence beliefs in the English and social domains. But boys and girls didn't differ in how much they value mathematics.

Moreover, in the study of Vanayan, White, Yuen and Teper (1997), it was found that there were no gender and grade differences in students' beliefs about the process of learning mathematics. Stipek and Gralinski (1991) stated that females had greater tendency to avoid mathematics courses and occupations. Having more negative beliefs related to their competencies and the likelihood of success, girls took less pride in their success than did boys and after failure experienced either more negative emotion or greater concern about public humiliation than did boys. According to them, girls were also less likely to believe that success could be achieved through effort, and they had stronger desires to avoid mathematics learning situations.

Therefore the last concern of the present study is to investigate the differences between girls and boys with respect to beliefs about mathematics and the teaching of mathematics with high school students in Ankara, Turkey.

In summary, the assessment of students' beliefs about mathematics can help teachers plan instruction and structure the classroom environment so as to help students develop more enlightened beliefs about mathematics and mathematics learning (NCTM, 1989). Aksu, Demir and Sümer (2002) noted that 'the assessment of students' beliefs about mathematics can be one of the important starting points for the improvement of mathematics instruction" (p 73). Thus, knowing students' beliefs about themselves and mathematics can help to find the way of how we teach mathematics effectively and how we act to students during class session. Although, there are very large numbers of studies on beliefs, research studies related to high school students' beliefs about mathematics and the teaching of mathematics are very few. Thus, in the present study, it is aimed to understand the high school students' beliefs about mathematics and the teaching of mathematics. While doing this, different school types, students' mathematics achievement level, branches and gender are also considered.

Kloosterman and Stage (1992) noted that availability of an instrument to mathematics instructors allowed measuring the beliefs of their students willingly. According to him, this would allow them to determine the beliefs of their students and then modify instruction to improve beliefs if needed. In the present study, second aim is to develop scales for high school students to understand their beliefs about mathematics and the teaching of mathematics.

CHAPTER 2

THEORETICAL BACKGROUND OF THE STUDY

This chapter is a summary of the theoretical background of the present study. It consists of four sections: the definitions of beliefs and belief system, beliefs about mathematics, relation between beliefs and learning, differences between beliefs and other similar concepts.

2.1 Definitions of Beliefs and Belief System

In this section some definitions related to beliefs and belief system will be given briefly.

2.1.1 Definitions of Beliefs

There was considerable interest among social psychologists in the study of the nature of beliefs and their influence on people's action (Thompson, 1992). That beliefs are studied in diverse fields has resulted in a variety of meanings, and the educational research community has been unable to adopt a specific working definition (Thompson, 1992; Pajares, 1992). Brown and Cooney (1982) explained that beliefs are dispositions to action and major determinants of behavior.

There are many definitions of beliefs. Some of them were stated as follows:

Scheffler (1965) defined belief as:

> *"A belief is a cluster of dispositions to do various things under various associated circumstances. The things done include responses and actions of many sorts and are not restricted to verbal affirmations."(p.85)*

Fleener (1996) states that beliefs filter experiences to help individuals face conflict, resolve contradiction, and cope with uncertainty. That is, beliefs guide behavior and help individuals adapt to their environment.

Sigel (1985) defined belief as "mental constructions of experience -often condensed and integrated into schemata or concepts that guide behavior" (p 351). Harvey (1986) defined belief as "an individual's representation of reality that has enough validity, truth, or credibility to guide thought and behavior" (p 152). Ernest (1989) stated that beliefs are personal views, assumptions and values.

Dewey (1933) described belief as:

> *'Something beyond itself by which its value is tested; it makes an assertion about some matter of fact or some principle of law. It covers all the matters of which we have no sure knowledge and yet which we are sufficiently confident of to act upon and also the matters that we know accept as certainly true, as knowledge, but which nevertheless may be questioned in the future" (p. 313)*

Rokeach (1968) argued that "all beliefs have a cognitive component representing knowledge, an affective component capable of arousing emotion, and a behavioral component activated when action is required" (p 314).

In the present study, belief is defined as an individual's conceptions, values, ideology, dispositions, philosophies of life and philosophies of mathematics.

2.1.2 Definitions of Belief System

Green (1971) stated that the notion of belief system is a metaphor for examining and describing how an individual's beliefs are organized. While investigating the literature, it was found that there were different definitions of 'belief system' that were stated as follows:

Thompson (1992) stated that "belief systems are dynamic in nature, undergoing change and restructuring as individuals evaluate their beliefs against their experiences" (p 130).

To distinguish between beliefs systems and knowledge systems Nespor (1987) wrote that

> *"Belief systems often include affective feelings and evaluations, vivid memories of personal experiences, and assumptions about the existence of entities and alternative words, all of which are simply not open to outside evaluation or critical examination in the same sense that the components of knowledge systems are." (p 321)*

Rokeach (1968) defined a belief system as "having represented within it, in some organized psychological but not necessarily logical form, each and every one of a person's countless beliefs about physical and social reality" (p 318). According to Pajares (1992), his analysis included three assumptions:

> *"Beliefs differ in intensity and power; beliefs vary along a central-peripheral dimension; and the more central a belief, the more it will resist change" (p 318)* .

Green (1971) identified three dimensions of belief systems, having to do not with the content of the beliefs themselves, but with the way in which they are related to one another within the system. The first of these dimensions has to do with the observation that a belief is never held in total independence of all other beliefs, and that some beliefs are related to others in the way that reasons are related to conclusions. Thus, belief systems have a quasi-logical structure, with some *primary* beliefs and some *derivative* beliefs (Thompson, 1992). He also gave the example to illustrate this dimension that a teacher who believes "important to present mathematics clearly to the students" (primary belief) also believes "important to prepare lessons thoroughly, to ensure a clear, and a sequential presentation" (derivative belief). Green (1971) gave the second dimension related to the degree of conviction with which beliefs are held or to their psychological strength. According to Green, the beliefs in the system can be viewed as either *central* or *peripheral* that the central ones being the most strongly held beliefs, and the peripheral ones those most susceptible to change or examination. The third dimension claimed, "beliefs are held in clusters and protected from any relationship with other sets of beliefs".

Schoenfeld (1985) pointed out the functioning of belief systems. He clarified that:

> *"Belief systems are one's mathematical world view, the perspective with which one approaches mathematics and mathematical tasks. One's beliefs about mathematics can determine how one chooses to approach a problem, which techniques will be used or avoided, how long and how hard one will work on it, and so on. Beliefs establish the context within which resources, heuristics, and control operate."(p 45)*

2.2 Beliefs About Mathematics

The role of beliefs for the successful learning of mathematics has been researched by several researchers (Pehkonen & Törner,1999; Kloosterman,1999) . Pehkonen and Törner (1999) gave the reasons of the effects of beliefs on mathematics: (1) Beliefs may have powerful impact on how children learn and use mathematics, and thus they may also form an obstacle for the effective learning of mathematics. (2) Pupils who have rigid and negative beliefs of mathematics and its learning easily become passive.

Pehkonen and Törner (1999) defined mathematical beliefs into four groups:

(1) *Mathematical beliefs as a regulating system:* They are easily understood when we remember that an individual's mathematical beliefs form a frame for his knowledge structure.

(2) *Mathematical beliefs as an indicator:* Mathematical beliefs may be a practical indicator in a situation, which one is not to be able to observe. It is obvious that beliefs of pupils as well as of teachers present condensed information on personally experienced "meetings" with cognitive element in the past.

(3) *Mathematical beliefs as a force of inertia:* If it is aimed to change the teaching of mathematics in schools, teachers' beliefs as well as pupil's beliefs are taken into account as a possible force of inertia.

(4) *The prognostic character of mathematical belief systems*: It also should be stressed that mathematical belief systems also have a prognostic aspect. Pupils who consider mathematics as a manipulative calculation system only have an ignorant attitude toward problem solving, and thus their opportunities to learn effectively in school are restricted.

Kloosterman (1999) categorizes beliefs as: mathematics is computation, mathematics requires proof, mathematics is useful, math topics are integrated, and mathematics consists of clearly defined problems. Some of the beliefs in Kloosterman's category include self-confidence in solving routine and non-routine mathematics problems, self-confidence in learning various math topics, and beliefs about the role of teacher. This category related to beliefs about mathematics includes: memorization is important in mathematics, students learn in different ways and learning involves connecting new information to what is already known.

2.3 Relation Between Beliefs and Learning

Researchers have investigated how beliefs that individuals hold about knowledge and knowing affect the learning process. The general agreement among researchers that students' beliefs have an important influence on mathematical learning and problem solving, from a conceptual as well as from an empirical viewpoint there is still a lack of clarity (Eynde, Corte & Verschaffel, 1999).

Pajares (1992) stated that the earlier a belief is incorporated into the belief structure, the more difficult it is to alter. For these beliefs subsequently affect perception and strongly influence the processing of getting new information. He also stated that newly acquired beliefs are most vulnerable and with time and use, they become robust, and individuals hold on to beliefs based on incorrect or incomplete knowledge even after significantly correct explanations are presented to them.

Pajares (1992) suggests that there are number of conditions that before students find anomalies uncomfortable enough to accommodate the conflicting information: First they must understand that new information represents an anomaly. Second, they must believe that the information should be reconciled with existing beliefs. Third, they must want to reduce the inconsistencies among the beliefs. And the last, efforts at assimilation must be perceived as unsuccessful.

He also stated that students are generally unaware of their anomalies and if conceptual change takes place, newly acquired beliefs must be tested.

Schoenfeld (1985) found that students seemed to believe that only the gifted could derive theorems or be creative in mathematics. He also stated that some students seemed to believe in quick, all-or-none learning. They spend 10-12 min to solve a problem. If they don' t get it the answer, they assume they never will get it.

Epistemological beliefs play a role in knowledge interpretation and achievement. Schommer (1990) conducted two experiments to explore students' beliefs about the nature of knowledge and their effect on comprehension and concluded that epistemological beliefs affected the students' critical interpretation of knowledge, their information processing strategies, and their efforts at comprehension monitoring. A belief, she found, can distort information so as to remain self-consistent, a finding in keeping with the perseverance phenomena.

2.4 Differences Between Beliefs and Other Similar Concepts:

In this section of the study differences between "belief" and "knowledge" and differences between "belief" and "attitude" will be summarized briefly.

2.4.1 Differences Between "Beliefs" and "Knowledge"

Thompson (1992) noted the close connection that exists between beliefs and knowledge. Belief is usually seen as a construct that has a cognitive component but is a weaker condition than knowing. Scheffler (1965) claimed that belief is necessary but not sufficient condition for knowing. That is, we can say that if we know something, we also believe it, but if we believe something, we may not really know it.

Beliefs have been distinguished from knowledge in a number of ways:

- Beliefs can be held with varying degrees of conviction.
- Beliefs are not consensual- the believer is aware that others may think differently.
- Beliefs are often held or justified for reasons that don't meet criteria involving canons of evidence.
- Beliefs are characterized by a lack of agreement over how they are to be evaluated or judged (Thompson, 1992).

According to Thompson (1992):

> *'From a traditional epistemological perspective, a characteristic of knowledge is general agreement about procedures for evaluating and judging its validity; knowledge must meet criteria involving canons of evidence. Beliefs, on the other hand, are often held or justified for reasons that do not meet those criteria, and thus, are characterized by a lack of agreement over how they are to be evaluated or judged'(p.130)*

Nespor (1987) suggested that beliefs have stronger affective and evaluative components than knowledge and that affect typically operates independently of the cognition associated with knowledge.

Ernest (1989) suggested that knowledge is the cognitive outcome of thought and beliefs the affective outcome, but he acknowledged that beliefs also possess a slender but significant component. He also explored that the effects of teachers' knowledge of mathematics and concluded that two teachers may have similar knowledge but teach in different ways.

Pajares (1992) stated that 'beliefs are seldom clearly defined in studies or used explicitly as a conceptual tool, but the chosen and perhaps artificial distinction between belief and knowledge is common to most definitions: Belief is based on evaluation and judgment; knowledge is based on objective facts" (p 313).

2.4.2 Differences Between "Beliefs" and "Attitudes"

Sometimes "attitude" and "belief" can be confused in spite of not having the same meanings:

Ernest (1989) explain "attitude" toward mathematics as including liking, enjoyment, and interest in mathematics.

Baydar (2000) noted that attitudes are somehow related to emotions and feelings. Beliefs, on the other hand, have cognitive roots. He also stated that beliefs are more questionable than attitudes. According to him, if an individual simply likes the red color, no one can ask to his or her why he/she likes red color. But if he or she believes that red is the most appropriate color for women, this is questionable.

Some researches related to both "attitude" and "belief" divide these concepts separately. Ma (1997) investigated the reciprocal relationship between attitude toward mathematics and achievement in mathematics. Instrument that was related to students' attitudes toward mathematics includes the terms importance, difficult, and enjoyable. Vanayan, White, Yuen and Teper (1997) divide attitudes and beliefs in their survey study. The survey contained 22 items that addressed students' attitudes and beliefs regarding mathematics. The items on the survey "I like mathematics", "I like to so lve mathematics problems that make me think", "I am good at mathematics", "Mathematics is hard for me" were taken as students' attitudes toward mathematics, the items "Most people need to know mathematics for their jobs", "Learning mathematics is mostly me morizing", "There is usually one way to solve a mathematics problem" were taken as students' beliefs about mathematics.

In summary, this chapter presented an in-depth discussion of the research related to definitions of belief and belief systems to identify definitional problems and differing understanding of them. Many different definitions of beliefs and belief systems were given in this chapter and generally, belief can be defined as a feeling of certainty that something exist, is true or is good that guide behavior. In the present study, belief is defined as an individual's conceptions, values, ideology, dispositions, philosophies of life and philosophies of mathematics. In addition, this chapter also presented the research studies related to beliefs about mathematics and relation between beliefs and learning to identify students' beliefs about mathematics and how these beliefs affect learning. Moreover, it also includes a discussion of the differences between beliefs and other similar concepts: "belief" and "knowledge"; "belief" and "attitudes". Generally, in the literature, belief and knowledge are distinguished from each other that belief is a weaker condition than knowledge and it is based on evaluation and judgment; on the other hand, knowledge is based on objective facts. In addition, attitude is distinguished from belief that includes liking, interesting, enjoyment. In the present study, it was used only the items that are related to "beliefs" not "attitudes" for the scales.

CHAPTER 3

REVIEW OF THE LITERATURE

In this chapter, the literature related to the present study is reviewed. Based on the content and the main objectives of the study, the literature is classified into two sections: studies on students and teachers' bel iefs about mathematics and the teaching of mathematics, and studies on gender differences related to beliefs about mathematics and the teaching of mathematics.

3.1 Studies on Students and Teachers' Beliefs About Mathematics and the Teaching of Mathematics

The beliefs that students and teachers hold about mathematics and teaching of mathematics have been well documented in the research literature in recent years. These commonly held beliefs include the following:

• Mathematics is computation.

• Mathematics problems should be solved in less than five minutes or else there is something wrong with either the problem or the student.

• The aim of doing a mathematics problem is to obtain the correct answer.

• In the teaching-learning process, the teacher is active and the student is passive (Frank, 1988).

3.1.1 Studies on Students' Beliefs about Mathematics and The Teaching of Mathematics

Schoenfeld's work (Schoenfeld, 1985) and the previous findings showed that many students appear to hold a lot of incorrect beliefs about mathematics. Corte and Eynde (2003) stated that according to several studies, beliefs about mathematics, mathematical learning and problem solving determine how one chooses to approach a problem and which techniques and cognitive strategies will be used. Nevertheless, they noted that the few studies that investigated the relation between beliefs and emotions indicated that indeed students' beliefs about mathematics education provide an important part of the context within which emotional responses to mathematics develop.

Corte and Eynde (2003) were convinced that the study of students' mathematics-related belief systems, more than the study of isolated beliefs. According to them, it might present a unifying framework for research on students' mathematics-related beliefs, resulting in more systematic research efforts and leading to a more comprehensive understanding of how beliefs influence mathematics learning and problem solving. They discussed an initial study based on a survey study of 365 Flemish junior high school students, that analyzes the structure of students' mathematics-related belief systems. It tried to identify the different constituting components of students' belief systems in relation to each other. They developed a more integrated instrument that asked students about their beliefs on mathematics education, on the self in relation to mathematics, and on the social context in their specific class. The Mathematics-Related Beliefs Questionnaire containing 58 items that are scored on a 6 point Likert-scale, from 0 (I completely disagree) to 5 (I totally agree). The correlations between the different factors indicated that students holding a more social, dynamic view of mathematics attached more value to mathematics and had more confidence in their mathematical capacities. Moreover, they also tended to have more positive beliefs about the teacher and his functioning in class. The results also showed that students holding positive beliefs about their teacher also considered mathematics more valuable and felt more confident about it. According to researchers, students who were confident about their mathematical ability were mostly also the ones who were convinced about the relevance of mathematics. Those with low self-confidence, on the other hand, were also not convinced of the importance of mathematics.

The most common method of measuring beliefs has been though interview and observation. These methods are very useful to deep understanding of students' beliefs and to get self-reports for measuring beliefs in detail. But they are also very time consuming and so are not practical for large samples. Kloosterman and Stage (1992) developed a set of belief scales for measuring secondary school and college students' beliefs about mathematics as a subject and about how mathematics was learned. According to them, if an instrument were available to mathematics instructors, many would be more willing to measure the beliefs of their students. This would allow them to determine the beliefs of their students and then modify instruction to improve beliefs if needed. The assumption behind their work was that some students' beliefs result in high motivation for the student and some beliefs diminish motivation. The instrument was developed in the context of problem solving so the scales were designed to measure beliefs that are related to motivation and achievement in problem solving. Before presenting the scales, they described types of beliefs, which are related to motivation. First belief for the students that were taken to the instrument was about their ability to solve problems that take more than a minute or two to complete. Second belief studied was that there are word problems that cannot be solved with simple, step-by-step procedures. Third belief selected for the study involved the importance of conceptual understanding in mathematics. This belief result in agreeing or strongly agreeing with the statement "Knowing why an answer is correct is as important as getting the correct answer" by the eighty-nine percent of the eleventh-grade students in the national assessment sample. The fourth belief selected for the study involved perceptions of the importance of word problems. Students who believe computation is the key to mathematics learning will have less motivation to be good problem solvers than students who feel that solving word problems is important. Final students' belief was that effort could increase mathematical ability.

Kloosterman (1999) stated that studies on students' value and/or expectancy beliefs in the context of mathematical learning and problem solving clearly show how these beliefs relate to students' motivation and the way they engage in mathematical learning and problem solving as well as their influence on achievement. In his paper "Mathematical beliefs and motivation of high school students in the United States", addressed the issues of what United States High school students think mathematics is and how important memorization is in the learning process. The data reported in his paper came from a larger study that 56 high school students were interviewed. Students also completed the Indiana Mathematics Belief Scale (IMBS-Kloosterman & Stage, 1992) and their teachers completed a short questionnaire about their motivation and achievement in mathematics. The students who were enrolled in mathematics courses were selected from 4 schools and representing both rural and small city populations. Some of the interview questions which were related to the nature of mathematics were: "*Suppose an alien from outer space landed in your back yard and started asking you what math was like in Indiana. What would you tell him? What words best describe mathematics*"; "*How important is memorization in mathematics? Are you god at memorizing? Can someone who is not good at memorizing be good in mathematics?"*. According to the students' responses of these questions, the researcher concluded that the nature of mathematics as a discipline is not an issue that United States high school students think about. When they were pressed to talk about the nature of mathematics, they mentioned that mathematics could be used to solve a variety of problems and that it involved numbers. In addition, they sometimes mentioned the logical nature of mathematics but almost never mention the deduction of proof. The majority of students assumed that "math is math". Most of them that were interviewed found it difficult to describe the nature of mathematics and thought mathematics was a set of rules to be mastered. The researcher stated that students tend to feel that memorization, and the ability to memorize procedures, is an important part of being successful in mathematics. On the other hand, they also felt that students who were not good at memorizing can still learn mathematics if they work hard enough.

Much of the research concerning mathematics anxiety and beliefs about mathematics has been conducted with elementary, secondary and traditional college students (Gonske, 2002; Austin & Wadlington, 1992). Gonske (2002) examined the relationships among math anxiety, beliefs about the nature of the learning mathematics, and students' learning approaches, specifically of nontraditional students at the college. In the study, both qualitative and quantitative research studies were used. For quantitative part, two hypotheses related to beliefs were examined in the study: (1) Beliefs about the nature of mathematics, beliefs about learning mathematics, and learning approaches are significantly correlated with varying levels of mathematics anxiety; (2) There are significant correlations between beliefs about the nature and the learning of mathematics and students' learning approaches. The sample was 129 nontraditional students. The results of the correlational and hierarchical regression analyses of the survey data indicated few statistically significant correlations among the variables. Despite the lack of statistically significance, beliefs were primarily negatively related to math anxiety. For the qualitative part of the study, 14 students were asked some open-ended questions to understand their beliefs about the nature of math and learning math. From the interview, one common idea about the nature of math was that mathematics was rigid and rule based. One of the participants believed that "There are rules and you learn them and you do it that way and that is math. No gray area, no creative, it is black and white". The belief that "math is useful in daily life" was one of the beliefs addressed in the survey. Some participants were very confident that they had the ability to do mathematics if they put the appropriate effort into it. Interview participants had much to say concerning their views on the importance of understanding or memorizing in the process of learning mathematics. Most of the participants thought there are step-by-step procedures for solving most math problems and there are some things that simply must be memorized. Students indicated the greatest agreement with the belief that understanding concepts was important in mathematics. Students agreed that effort could increase ability in mathematics and that mathematics was useful in daily life but were somewhat uncertain about the importance of word problems.

Other investigation related to the relationships between the mathematics beliefs and math anxiety done by Austin and Wadlington (1992) was examining the effects of mathematics beliefs on math anxiety and math self-concept of college students. Fifty pre-service and 15 in-service teachers participated in their study. According to them, math anxiety was not the only reason for lowered math scores in the United States but it was a very important one. Three questionnaires were used: mathematics anxiety rating scale, mathematics self-concept test, and a specially developed test. Although other studies suggest that the relationship exists between math anxiety and negative math self-concept, such a relationship couldn't be found in this study. In the study, mathematical beliefs of high-anxious pre-service teachers, low-anxious pre-service teachers, and in-service teachers were compared. For the most part, calculated percentages indicated that beliefs of the three groups were similar. In addition, 73% or more of all three groups believed "Math requires a good memory".

Qualitative study provides to further understanding. One of the qualitative studies related to the students' beliefs about mathematics was done by Spangler (1992). The researcher asked some open-ended questions to the students to assess their beliefs about mathematics. In this article, it is presented some open-ended questions that were used to address students' beliefs about mathematics. These questions have been used by the author with elementary, junior high, and senior high school students; pre-service and in-service elementary, junior high, and senior high school teachers; and graduate students in mathematics education. In the article, the researcher asked to students:

"*…If given a choice, would you prefer to have a) one method which works all the time or b) many methods which work* all *the time when solving a problem?*"

According to given answers, she concluded that most of the students would prefer to have one method for solving a problem because they do not have to remember as much as if they had multiple methods. Thus students perceive memorization as a major component of mathematical learning.

Most students gave the answer "yes" for the question "... *Is it possible to get the right answer to a mathematics problem and still not understand the problem? Explain."* This shows that they can obtain correct answers without understanding what they are doing all too often.

"...How do you know when you have correctly solved a mathematical problem?"

Reworking the problem, checking with the teacher or a classmate, looking in the back of the book, working backwards (in the case of arithmetic) or plugging in values (in the case of algebra) were common answers to this question.

"...*What subject(s) is mathematics most like? Least like?* "

The most popular answer to this question was that mathematics is most like science because it involves memorizing formulas and working with numbers. Virtually all other subject areas fall into the category of being least like mathematics.

"... If you were playing "Password" and you wanted a friend to guess the word "mathematics", what clues would you give? ("Password" clues must be one word and may not contain any part of the word mathematics."

For this question students gave the answers predictably, add, subtract, multiply, and divide. Other clues include numbers, problems, operations, calculate, hard, and subject. According to these responses the researcher concluded that students tend to view mathematics as synonymous with arithmetic.

In addition, according to another question in the article, the students see the mathematicians as a man who is older with gray Einstein-like hair, wearing glasses. The mathematician is often in a nondescript room, and there are no other people around. These observations suggest that students view mathematics as a solitary endeavor that is carried out in a place very different from their everyday surroundings. They also apparently view mathematics as a male-dominated discipline (Spangler, 1992).

One of the descriptive studies was done by Vanayan, White, Yuen and Teper (1994) about beliefs and attitudes toward mathematics among third and fifth grade students. The instrument used for survey study consisted of 22 items and these items were categorized into three sections: (a) Liking Mathematics, (b) Perceived Mathematics Competence, (c) Beliefs Regarding Mathematics Relevance. According to the result of the study, about half the students in both grades (64%) agreed that learning mathematics is mostly memorizing, whereas, the remainder either disagreed or were unsure. Nonetheless, in both grades, between 85% of students thought that there are usually many ways to solve a mathematics problem. Students in both grades appeared to recognize that there was a relation between learning mathematics and learning other subjects, supporting an integrated view of learning. Although nearly one third of the students in both grades were unsure about the relation of learning mathematics and other subjects, about 20% of students indicated that learning mathematics was most like learning either language or art, and more than 30% indicated that mathematics was mostly like learning science. In addition, according to students' responses, it was found about their perceptions of the mathematical processes that children of both sexes should learn mathematics (for the item 'I think that both boys and girls should learn mathematics') and parents really wanted them to learn mathematics (for the item 'My parent(s) really want me to learn mathematics'). Moreover, it was found in the study that more students in Grade 5 seemed to be aware of the usefulness and relevance of mathematics outside of school that mostly students said "yes" for the items 'they need to mathematics in order to get a job' and 'most people need to know mathematics in order to get a good job'. This is because perceived usefulness is thought to be an important determinant of activity choice. According to the researchers, it might therefore the valuable to make mathematics seem relevant in the early grades, perhaps by providing students with real life applications more frequently.

Fleener (1996), University of Oklahama, investigated high school students' beliefs about mathematics and science during a for week summer residential mathematics and science program. In the study, beliefs about mathematical and scientific truths, the value and importance of mathematics and science inquiry, gender equity and ability with respect to pursuit of mathematics and science careers, the relationship between mathematics and technology, and the role of science in society were examined. In addition, Habermasian ways of knowing were used to categorize student beliefs and determine student worldviews. The researcher investigated the answers of the questions: 'What beliefs do high school students have about scientific and mathematical-building and practice?' and 'What are the world views of students as suggested by their beliefs about scientific and mathematical knowledge-building?'. The participants were 20 high school students who came from a variety of school and academic backgrounds considered strong mathematics and science students. Students completed mathematics and science beliefs instruments. In order to answer the first question, "What beliefs do high school students have about scientific and mathematical-building and practice?" the researcher tabulated the results of the beliefs inventory by determining items upon which there was agreement, disagreement, mixed and uncertain responses. The second question, "What are the world views of students as suggested by their beliefs about scientific and mathematical knowledge-building?" was answered by categorizing belief-orientations using Habermas's categories.

According to students' answers, no disagreement on the item "Mathematical innovations result from scientific inquiry and practical applications" suggested the belief that changes in knowledge about mathematics are a result of scientific, empirical investigations which are revealing truths about reality. This is consistent with responses to item 'there are some mathematical truths which will never be proven wrong." Which suggests students view mathematics as given truths which may be revealed through scientific-empirical investigations. In the results, strong agreement with the items "Knowing mathematics and science profits all students" and "mathematics and science develops good reasoning ability" suggests students' value learning existing mathematical and scientific knowledge. Students gave mixed responses to the items "Mathematics is changing", "there are often many correct solutions to a math problem" and "Computers can do things human can not". According to the researcher, this reinforced the idea that elementary and high school experiences with mathematics do not reveal mathematics as a dynamic, changing discipline and do not deal with issues of computer capabilities and limitations. In summary, in the study, students had well defined core beliefs about the nature of mathematical and scientific truths, the value and importance of engaging in mathematical and scientific inquiry, and equity with respect to gender and background for pursuing mathematics and science related careers.

Schoenfeld (1989) investigated the relationships between students' beliefs about mathematics-their sense of mathematics as a discipline, and between students' understandings about the nature of deductive proof in geometry. The participants were 230 students enrolled in high school mathematics courses. The instrument containing 81 open-ended and closed items were related to attributions of success of failure; students' perceptions of mathematics and school practice; their views of school mathematics, English and social studies; the nature of geometric proofs, reasoning, and constructions, motivation and personal and scholastic performance. The results of the study showed that the students considered mathematics to be an objective, and it could be mastered. They believed that if someone got good grade in mathematics, he or she would work, that is, luck couldn't be the reason to take good grades. They believed that if the students do poorly, this is their own fault. Students' beliefs about teaching practice in mathematics was that the good teaching practice in mathematics, consists of making sure that students know how to use the rules and showing students lots of different ways to look at the same question. The results also showed that the students to be highly motivated like finding the subject matter interesting or being aware of the uses of the discipline. According to the study, students think that mathematics is best learned by memorization.

Effects of beliefs about the nature of knowledge on comprehension were investigated by Marlene Schommer (1990). The researcher addressed the two questions: (1) "What are students' beliefs about the nature of knowledge?" and (2) 'How do these beliefs affect comprehension?". Students' epistemological beliefs were assessed with an epistemological questionnaire. This questionnaire includes the items: (a) "Knowledge is simple rather than complex", (b) "Knowledge is handed down by authority rather than derived from reason", (c) "Knowledge is certain rather than tentative", (d) "The ability to learn is in nate rather than acquired", and (e) "Learning is quick or not at all". 117 junior college students and 149 university students participated as subjects. The results showed that the more classes the students had completed in higher education, the more likely they were to believe knowledge is tentative. According to the researcher, this suggests that exposing students to more advanced knowledge, which is generally more tentative in nature, facilitates a change in their belief systems with regard to the uncertainty of knowledge. In addition, the results of the study also showed that the older the students were, the more likely they were to believe that the ability to learn is acquired. An important finding of the study was that epistemological beliefs seem to affect students' processing of information and monitoring of their comprehension.

There are also some studies on pupils' beliefs about mathematics teaching. Such a study was done by Erkki Pehkoren from Finland, and Klara Tompa from Hungary (Pehkonen & Tompa, 1994) on an international scale. They compared Finnish and Hungarian seventh grade students' conceptions (beliefs) of mathematics teaching. The leading phrase they used for all the statements in their questionnaire was: 'What does good mathematics teaching include?'. For their quantitative study 200 students from Hungary and Finland answered the questionnaire. They found out that the Finnish students were more in favor of calculation-centered working than their Hungarian counterparts. The Hungarian preferred exact teaching methods, which strive for understanding according to students' capabilities and computational aspects of mathematics such as rapid performance, correct answers, the memorization of rules and beliefs in the existence of proper procedures.

In Turkey, the study on students' beliefs about mathematics and learning to mathematics was done by Aksu, Demir and Sümer (2002). Their study was related to primary school students' beliefs about mathematics. The purposes of the study were to investigate what beliefs of primary school students have about mathematics and how difference occur students' beliefs according to sex, grade level and level of mathematics. The 563 participants were selected from two primary schools (one private, one public) in Ankara, Turkey. To measure the students' mathematics beliefs the instrument "Beliefs about Mathematics Survey" was developed and used by the researchers. The scale consisted of 20 items related to 'beliefs about the process of learning mathematics', 'beliefs about the use of mathematics' and 'beliefs about the nature of the mathematics'. According to students' expressions varying degrees of agreement or disagreement with the 20 statements, the researchers examined and interpreted the responses: The students believed that mathematics always required finding the correct answer, and there was only one method of solution to a problem which was taught by the teacher, one had to be quick and correct. These beliefs were supported with Garofalo (1989) by the researchers. According to him, students who held the belief that math problems should be solved by the method taught by the teacher tend to spent their time studying mathematics by memorizing the facts, formulas and practicing procedures rotely. Therefore, they usually don't spent time trying to understand mathematical thinking (in Aksu, Demir, Sümer, 2002). When the items related to "Beliefs about the use of mathematics" were examined, it was seen that students mainly agreed with all the items related to the use of mathematics. According to the researchers, this showed that students believed in the use of mathematics and the usefulness of mathematics outside of school. In addition, it was examined whether students' beliefs about the nature of math, the process of learning mathematics and the use of mathematics differ according to sex, grade level and math achievement in the study.

3.1.2 Studies on Teachers' Beliefs about Mathematics and The Teaching of Mathematics

Some researchers examine teachers' beliefs about mathematics. These researchers use a variety of methods to identify teachers' conceptions, including interviews, questionnaires, and inferences based on teachers' practices. These studies generally highlight the influence of teachers' assumptions about mathematics on their teaching of the subject.

Various studies on mathematics teachers' beliefs and conceptions have consistently confirmed one major idea: that mathematics teachers' beliefs and conceptions, particularly about the nature of mathematics and about the teaching and learning of mathematics influence the type of mathematics instruction they deliver in the classroom. Thompson (1992) identified several studies in mathematics education that have indicated that beliefs about mathematics and its teaching play a significant role in shaping the teachers' patterns of instructional behavior. In particular, Thompson (1992) concluded that the relationship between teachers' conceptions and their instructional decisions and behavior is a complex one. In the study of three junior high school teachers, the researcher found that the quality and level of these teachers' reflection about their beliefs contributed to the presence or lack of congruence between their beliefs and their instructional behavior, making the said relationship complex. Additional conceptions about their students and the social and emotional make-up of the classroom also affect their instructional behavior patterns, perhaps, much more for some teachers. These conceptions likewise affect teachers' view about mathematics and its teaching.

Deborah Loewenberg Ball (1988), in her article, stated that the prospective teachers have beliefs about mathematics included the following:

• Doing mathematics means following set procedures step-by-step to arrive at answers.

• Knowing mathematics means knowing "how to do it."

• Mathematics is largely an arbitrary collection of facts and rules.

Educators involved in the current reform movement in mathematics education recommend that students be actively involved in constructing their own knowledge and developing powerful mathematical concepts (Steele & Widman, 1997). They studied about how ideas based on constructivist learning theory can be put into practice in a preservice mathematics education class. Conceptions are composed of two components: beliefs and knowledge. Steps taken to ensure the validity and reliability of the research included collecting data over a long period of time (4 months), using several methods of data collection (interviews, observations, and artifact collection), discussing findings with classroom participants, and keeping bias (researcher's own views) under control. During beginning and ending interviews, students were asked the questions: What is mathematics? What does it mean to know mathematics? How is mathematics learned? During the first class, each student had the opportunity to express his or her own ideas. In the study, all of these preservice teachers' responses reflected a traditional view of mathematics. They saw mathematics as being numbers, right answers, and correct way of solving problems. By contrast, at the end of the course, the students were beginning to see mathematics with new eyes. These students were becoming mathematical thinkers and in doing so were changing their conceptions about the nature of mathematics: There is no longer a "right" way to do math; there is "just the way one does math". The researchers concluded that when students begin to think about mathematics in new ways, they realize a confidence in their abilities to do mathematics.

In Turkey, the study related to teachers' beliefs about mathematics and the teaching of mathematics was done by Baydar (2000). His study was related to beliefs of pre-service mathematics teachers enrolled at the Mathematics Teacher Education Programs at the Middle East Technical University and the Gazi University about the nature of mathematics and teaching of mathematics. For his study, the survey research techniques were used. The results of the research showed that there was a statistically significant difference between the mean scores of pre-service mathematics teachers at METU and those at Gazi University in terms of beliefs about the nature of mathematics and the teaching of mathematics. But there was no strong difference between the mean scores. According to the researcher this slight difference occurred because of the different durations of practice teaching in the schools in these two universities. 'Teaching Practice Course" is taken at Gazi University only one semester, whereas students take this course for two semesters at METU. The researcher supported that the preserves mathematics teachers' practices were very important since the prospective teachers saw the school setting and professional teachers with teacher eyes and observe them and it was also the first time that the beliefs of these young teachers start affecting their teaching practice. The researcher supported the findings by Raymond and Santos (1995), and Manouchehri (1997). Raymond and Santos (1995) stated that teacher beliefs about what mathematics and what it meant to know, do, and teach mathematics might be driving forces in instruction of mathematical ideas. Manouchehri (1997) stated that the ways that teachers teach and the ways teacher evaluate the content are determined by what they believe about the nature of mathematics, mathematics learning, and mathematics teaching. In addition, the researcher concluded that there was a statistically significant relationship between beliefs of pre-service mathematics teachers about the nature of mathematics and about the teaching of mathematics. For examples the item related to nature of mathematics " Mathematics has no effect on cognitive development" was correlated with the item related to teaching of mathematics 'It is not teacher's responsibility to provide a student understand mathematics", the item "Mathematics is a subject that concerns everybody" was correlated with the item "Students should be explained why mathematics is taught", the item "mathematics is a science that explains natural events using numbers" was correlated with the item "students should be explained why mathematics is taught" .These conclusions showed "if an individual carries a certain belief about the nature of mathematics then he is expected to hold similar or related beliefs about the teaching of mathematics" (Baydar,2002).

3.2 Studies on Gender Differences Related to Beliefs about Mathematics

Gender differences have been researching and studied over past decades in terms of achievement, learning, beliefs, self-confidence, attitudes, ect. High school boys often outperform girls on achievement tests, especially tests that involve problem solving. Female students also take fewer advanced math courses than male students (Eccles et all, 1993). According to Eccles et al (1993), younger children's perceptions of competence and subjective task values were more positive than those of older children. Also, they reported that girls and boys valued mathematics equally, but boys were more likely to believe that they were more competent than girls. Theorists have proposed that these gender differences in test performance and choices are caused in part by gender differences in achievement related beliefs (Stipek & Gralinski, 1991).

In the study of Aksu, Demir and Sümer (2002), it was found that there was no significant difference between male and female students on "belief about the nature of math", "beliefs about the process of learning mathematics" and "beliefs about the use of mathematics". This result is also consistent with the previous findings that boys and girls have similar beliefs about mathematics (Baydar, 2000; Eccles et all, 1993).

Stipek and Gralinski (1991) assessed the hypotheses: Girls, in comparison with boys, are predicted (a) to have lower perceptions of competence in mathematics and lower initial expectations for success; (b) to attribute success less to high ability and to attribute failure more to low ability; (c) to feel less proud of success and to feel more ashamed of failure; (d) to be less likely to believe that success in mathematics can be achieved through hard work; (e) to expect to do less well on a subsequent test (junior high school students only) , and (f) to express a stronger desire to avoid mathematics performance situations in the future. In their study they also examined at what age gender differences in mathematics achievement-related beliefs and emotions emerge. The participants in the study were 194 third graders (94 girls and 100 boys 8 or 9 years old) and 279 junior high school students (143 girls and 136 boys 13 or 14 years old). The pretest asked to the students included what grade they thought they would get on the test, how good they are in math, how they thought they would compared to classmates and how difficult math was for them; and the posttest given to the students to ask what grade they received and to let them rate how proud and how ashamed they felt. After students rated their emotions, they were asked a series of attribution questions. The pretest results showed that younger children grade expectations were higher than older children and there were significant gender main effects for all four variables. As predicted, in comparison with girls, boys on average rated their competence in mathematics higher, expected higher grade, and expected to do better relative to their classmates. Girls claimed that mathematics was more difficult than did boys. Contrary to predictions, these gender differences were not weaker in third grade than in junior high school. The posttest results showed that the difference between girls and boys with respect to claiming their out comes were poor wasn't significant. In general, girls' achievement -related beliefs were more negative than boys' achievement-related beliefs. On average, girls rated their ability lower and expected to do less well on the examination than did boys. Also, girls attributed failure to low ability more than did boys and success to high ability less. In addition, According to the results, beliefs regarding whether success can be achieved through hard work were also associated with future expectations and avoid desires. Students tended to believe that success could be achieved through hard work was positively associated with future expectations and negatively associated with avoidance desires. Although girls at both grade levels were more likely than boys to claim that success was not always achievable by hard work, the younger children believed to a greater extent than did the older children, that anyone could do well if he or she really tried hard.

Vanayan, White, Yuen and Teper (1994) also analyzed students' responses to survey items with respect to gender. According to results, girls and boys in both 3 and 5 grades were equally likely to state that they liked mathematics and they liked the four basic strands of arithmetic, addition, subtraction, multiplication and division. About 12% of girls in both grades reported that mathematics was hard for them, but the percentage of boys who stated that mathematics was hard for them dropped from 14% in grade 3 to 9% in grade 5.But there was no gender difference that they needed to know mathematics in order to get a good job. An overwhelming majority of students indicated that both girls and boys should learn mathematics. In addition, more boys than girls in both grades reported liking measurement. This strand of mathematics typically involved much classroom activity and demonstration.

Eccles et al (1993) found gender differences in competence beliefs and values even among first-grade children. Boys' com petence beliefs about math and sports were higher than girls' beliefs, in contrast girls' competence beliefs were higher than boys for instrumental music and tumbling. Similarly, girls valued reading and instrumental music more than boys; the boys valued sports more than girls. Interestingly; there were no gender differences in the valuing of mathematics. There was also no Gender x Grade interactions in any domain, indicating that the size of the observed gender differences was as large among first graders as among fourth graders.

In summary, many researchers have been trying to identify the different kinds of students' beliefs about mathematics and the teaching of mathematics that influence learning to mathematics and also to understand the processes through which they develop and determine learning. But there was no research studies determining the beliefs of the students enrolled to different kinds of high schools and also different branches. In the present study, these variables will be considered. It will be also investigated to gender differences related to beliefs about mathematics and the teaching of mathematics.

The main problem of the present study is ‘what are the beliefs of high school students about mathematics and the teaching of mathematics?”

CHAPTER 4

METHOD

This chapter includes research design, main and sub-problems of the study, hypotheses, definition of terms, variables, subjects, instruments, procedure, assumptions and limitations, internal and external validity of the present study.

4.1 Research Design of the Study

The purpose of the study is to investigate the high school students' beliefs about mathematics and the teaching of mathematics.

In the present study, while examining the students' beliefs about mathematics and the teaching of mathematics, differences related to high schools, students' mathematics achievement level, branches, and gender will be investigated.

For this study the casual-comparative method was used that it is interested in students characteristics related to beliefs about mathematics and the teaching of mathematics:

In the study, "Beliefs About Mathematics" and "Beliefs About the Teaching of Mathematics" Scales were administered 10^{th} grade students enrolled to different kinds of high schools (general, Anatolian, vocational, and foreign language). Reliability and validity of the scales were tested before beginning of the main study.

4.2 Main and Sub-Problems of the Study and Associated Hypotheses

In this section main and sub problems and hypotheses are stated.

4.2.1 Main and Sub-problems of the Study:

The main problems and their subproblems of the study are the following:

P1. What are the beliefs of students who are enrolled to the different kinds of high schools about mathematics and the teaching of mathematics?

P1.1. Are there any statistically significant differences among the mean scores of students who are enrolled to the different kinds of high schools with respect to beliefs about mathematics?

P1.2. Are there any statistically significant differences among the mean scores of students who are enrolled to the different kinds of high schools with respect to scores of students' beliefs about the teaching of mathematics?

P2. What are the beliefs of high school students who have different mathematics achievement levels in terms of mathematics and the teaching of mathematics?

P2.1 Are there any statistically significant differences among the mean scores of students who have different mathematics achievement levels in terms of beliefs about mathematics?

P2.2. Are there any statistically significant differences among the mean scores of students who have different mathematics achievement levels in terms of beliefs about the teaching of mathematics?

P3. What are the beliefs of high school students who are in the different branches with respect to beliefs about mathematics and the teaching of mathematics?

P3.1 Are there any statistically significant differences among the mean scores of students who are in different branches with respect to beliefs about mathematics?

P3.2 Are there any statistically significant differences among the mean scores of students who are in different branches beliefs with respect to beliefs about the teaching of mathematics?

P4. What is the difference between girls and boys in terms of beliefs about mathematics and teaching of mathematics?

P4.1 Is there any statistically significant mean difference between male and female students with respect to beliefs about mathematics?

P4.2 Is there any statistically significant mean difference between male and female students with respect to beliefs about the teaching of mathematics?

P5. What are the overall pictures of students beliefs about mathematics and the teaching of mathematics.

4.2.2 Hypotheses of the Study:

The following null hypotheses are stated in order to investigate the main problems of the study. They were tested at a significance level of 0.05.

The hypotheses of the first main problem:

Ho1.1: There are no statistically significant differences among the mean scores of students enrolled to different kinds of high schools with respect to beliefs about mathematics.

Ho1.2: There are no statistically significant differences among the mean scores of students enrolled to different kinds of high schools with respect to beliefs about the teaching of mathematics.

The second main problem is examined by the following hypotheses:

Ho2.1: There are no statistically significant mean differences among students who have different mathematics achievement levels in terms of beliefs about mathematics.

Ho2.2: There are no statistically significant mean differences among students who have different mathematics achievement levels in terms of beliefs about the teaching of mathematics.

The third main problem is examined by the following hypotheses:

Ho3.1: There are no statistically significant mean differences among students who are in different branches in terms of beliefs about mathematics.

Ho3.2: There are no statistically significant mean differences among students who are in different branches in terms of beliefs about the teaching of mathematics.

The fourth main problem is examined by the following hypotheses:

Ho4.1: There is no statistically significant mean difference between the male and female students on beliefs about mathematics.

Ho4.2: There is no statistically significant mean difference between the male and female students on beliefs about the teaching of mathematics.

In addition, to test the hypotheses of the 2^{nd}, 3^{rd}, and 4^{th} main problems, hypotheses related to interaction among high schools, mathematics achievement level and gender will be tested with respect to beliefs about mathematics and beliefs about the teaching of mathematics:

- There is no statistically significant interaction between gender and high school with respect to beliefs about mathematics and beliefs about the teaching of mathematics.
- There is no statistically significant interaction between gender and mathematics achievement level with respect to beliefs about mathematics and beliefs about the teaching of mathematics.
- There is no statistically significant interaction between mathematics achievement level and high school with respect to beliefs about mathematics and beliefs about the teaching of mathematics.

- There is no statistically significant interaction between gender, high school and mathematics achievement level with respect to beliefs about mathematics and beliefs about the teaching of mathematics.

4.3 Variables of the Study

Independent variables in the present study are kinds of high schools (general high school, Anatolian high school, vocational high school, and foreign language high school), mathematics achievement level (high, moderate and low), branches (science, math-literature, social and vocational), and gender. Dependent variables are beliefs about mathematics and beliefs about the teaching of mathematics.

4.4 Definitions of the Terms

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

Beliefs: It refers to an individual's conceptions, values, ideology, dispositions, philosophies of life.

Beliefs about mathematics: Individual's conceptions, values, ideologies, dispositions, philosophies related to mathematics.

Teaching of Mathematics: Everything related to teaching of mathematics including pedagogical issues as well as its cognitive and affective dimensions.

Mathematics Achievement: Mathematics achievement refers to the subjects' mathematics grades of the last semester.

Mathematics Achievement Level: It refers to the students' mathematics achievement level dividing into three groups: Low achiever students (lowachv), moderate achiever students (modachv), and high achiever students (highachv) in terms of their mathematics grades in the last semester.

Low achiever students: It refers to students whose last semester mathematics grades are 0,1 or 2.

Moderate achiever students: It refers to students whose last semester mathematics grades are 3.

High achiever students: It refers to students whose last semester mathematics grades are 4 or 5.

Kinds of Schools: It refers to the four different high schools: Anatolian High School, foreign language high school, general high school and vocational high school.

Branches: It refers to three different braches: vocational, social, math-literature and science.

Vocational Branch Students: Students enrolled to vocational high schools.

4.5 Subjects of the Study

The subjects of the study were 425 10th grade high school students enrolled to different kinds of schools (vocational high school, general high school, foreign language high school, and Anatolian high school) in Ankara, Turkey.

The study was carried out during 2003-2004 academic year.

For the present study, convience-sampling was used to select the subjects: subjects of the present study were chosen based on their relative ease of access.

Table4.1 The Distribution of the Subjects with respect to Different High Schools

HIGH SCHOOL	Male	Female	TOTAL n(%)
Vocational High School	47	68	115 (27,1)
General High school	52	62	114 (26,8)
Foreign Language High School	40	55	95 (22,4)
Anatolian High school	48	53	101(23,8)
TOTAL n (%)	187 (44)	238 (56)	425 (100)

In the study, four branches were taken. These are vocational, social, math-literature and science branches. Students who are in vocational branch were taken from vocational high school students. This branch student takes math courses a few (see Appendix E). The students who are in social branch don't take math courses (see Appendix E). The students who are in math-literature branch take math courses more than vocational and social students. But they don't take science courses such as physics, chemistry and biology. Students who are in science branch take more math courses than the other groups. They are more likely to be interested in mathematics (see Appendix E). The number of the subjects at different branches is showed in Table 4.2.

Table 4.2 The Distribution of the Subjects with respect to Different Branches

BRANCHES	n	percentage
Vocational	115	27,1
Social	64	15,1
Math-Literature	145	34,1
Science	101	23,8
TOTAL	425	100

Students' mathematics achievement level was also considered in the study. Students were categorized into three groups according to their mathematics last semester grades: low achiever students, moderate achiever students and high achiever students. The students whose mathematics grades are 0,1 and 2 were named as low achiever students, the students whose mathematics grades are 3 were named as moderate achiever students and the students whose mathematics grades are 4 or 5 were named high achiever students. The distribution of the number of the students with respect to their mathematics achievement level is showed in Table 4.3.

Table 4.3 The Distribution of the Subjects with respect to their Mathematics Achievement Level

MathAchvL	n	Percentage
Lowachv	180	42,4
Modachv	91	21,4
Highachv	154	36,2
TOTAL	425	100

4.6 Measuring Instruments

In the present study, the following measuring instruments were used:

(1) Beliefs about Mathematics Scale (BaMS)

(2) Beliefs about the Teaching of Mathematics Scale (BTMS)

4.6.1 Beliefs About Mathematics Scale (BaMS):

Beliefs About Mathematics Scale was adapted from the scale developed by Baydar (2000). This scale was used to determine the high school 10^{th} grade students' beliefs about mathematics.

The procedure followed in the development of the BaMS is outlined below.

The item pool for BaMS was derived from (a) literature related to beliefs about mathematics (b) National Council of Teachers of Mathematics Standards (1989, 1991) (c) BaNoM scale developed by Baydar (2000) (d) observations and interviews results of students' beliefs about mathematics. The item pool consisted of 40 items related to beliefs about mathematics.

The scale was administered to 210 high school students in the Fall Semester of 2003-2004 academic years for the pilot study. Data were analyzed by using the "Statistical Packages for Social Sciences" (SPSS). The scale with 21 items was scaled on a five-point Likert Type Scale: Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree. The positively worded items were scored starting from strongly agree as 5, to strongly disagree as 1, and negatively worded items were reversed to a positive direction for scoring purposes.

To test the construct validity of the BaMS and to find its sub dimensions, factor analysis was performed. According to the initial principal component analysis, the first seven eigenvalues were 3.660, 1.748, 1.383, 1.330, 1.142, 1.046, and 1.027. The first factor accounted for 17.427% of the total variance and the second factor accounted for 8.325% of the total variance in BaMS scores. Factor loadings of the BaMS in the first factor ranged between 0.39 and 0.62. Factor loadings of the BaMS in the second factor ranged between 0.26 and 0.58. The factor loadings of the item "there is no need to have strong memory for mathematics" was 0.17.

For the purpose of analyzing the factor structure of the scale more precisely, this primary factor solution was rotated by the use of the varimax rotation. The eigenvalues were obtained as 17.427 and 8.835. The first factor explained 16.917% of the variation of total scores of the BaMS. Factor loadings of the BaMS in the first factor ranged between 0.27 and 0.67. Factor loadings of the BaMS in the second factor ranged between 0.19 and 0.59. The factor loadings with the values at 0.19 or above are presented in Table 4.4.

When items accumulated in each factor in Table 4.4 are written in open forms, the items in Factor 1 are related to the nature of the mathematics and the items in Factor 2 are related to learning to mathematics. Thus, we named factor 1 as "beliefs about the nature of mathe matics" and factor 2 as "beliefs about the learning to mathematics". Although, the factor loading of the item "there is no need to have strong memory for mathematics" was very low (see Table 4.4), it was also used in the scale BaMS because of the validity of the test.

Table 4.4 Results of Principal Component Analysis with Varimax Rotation for the BaMS

Item	Factor1	Factor2
Mathematics makes life easier.	0.67	
Mathematics is a way of thinking that human beings develop when they solve the problems they face in real life.	0.58	
Mathematics help people acquire logical thinking ability.	0.54	
Mathematics is not a tool used for the development of the civilization.	0.53	
Mathematics is not need for society.	0.53	
Mathematics is a language.	0.51	
Mathematics help people to develop their problem solving abilities.	0.49	
Mathematics is a science that explains natural events using numbers.	0.48	
Mathematics is a tool that helps other branches of science to develop.	0.48	
Mathematics is an art like picture, poetry or music.	0.47	
Mathematics is a play.	0.43	
There is no room for creativity in mathematics.	0.41	
Mathematics is a subjects that concerns everybody	0.33	
Mathematics has no effect on cognitive development	0.27	
People can have different mathematical ability		0.59
Mathematics can not be thought to everyone.		0.56
Mathematics requires logic but not intuition.		0.49
Mathematics is a science that only deals with the numbers.		0.45
The person who doesn’t like mathematics can not do it		0.37
Finding the correct answer is not the most important problem for mathematics.		0.33
There is no need to have strong memory for mathematics		0.19

The alpha reliability coefficient of the BaMS with 21 items was found as 0.71 in the pilot study of the present study. The item 'Mathematics requires logic but not intuition." measured two criteria, so it was divided into two items for the main study: 'Mathematics requires logic" and 'Mathematics requires intuition". In the main study, the alpha reliability coefficient of the scale with 22 items was found 0.78. The total score of BaMS was between 22 and 110. In addition, the experts in mathematics education checked content validity of the scale and grammar of the test was also checked by mathematics and literature teachers.

Thus, the BaMS have 22 items related to students' beliefs about mathematics. To gather the data for the present study, BaMS were administered to 425 10^{th} grade high school students in rural areas of Ankara in the Spring Semester of the 2003-2004 academic year.

4.6.2 Beliefs about the Teaching of Mathematics Scale (BTMS):

The scale was used to determine the high school 10^{th} grade students' beliefs about the teaching of mathematics. The item pool for BTMS was derived from (a) literature related to beliefs about the teaching of mathematics (b) BaToM scale developed by the researcher Baydar (2000) and (c) observations of the students' beliefs about the teaching of mathematics. To test the validity and reliability of the scale, pilot study was done with 210 high school students enrolled to the schools in Ankara in the Fall Semester of the 2003-2004 academic years.

In pilot study, data were analyzed by using the SPSS. The BTMS with 42 items was scaled on five-point Likert Type scale: Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree. The positively worded items were scored starting from Strongly Agree as 5 to Strongly Disagree as 1, and negatively worded items were reversed to for scoring purposes.

To test the construct validity of the BTMS and to find its sub dimensions, factor analysis was done. According to the initial principal factor solution with iterations, the first fifteen eigenvalues were 5.701, 2.800, 2.100, 1.919, 1.667, 1.563, 1.530, 1.430, 1.328, 1.303, 1.233, 1.156, 1.147, 1.108, and 1.034. The first factor accounted for 12.957% of the total variation. Factor loadings of the BTMS in the first factor ranged between 0.33 and 0.59.

When items accumulated in each factor are written in open forms, that items in each factor do not have a common point as a group. Thus, the items accumulated in each factor couldn't be named as a sub dimension. The loadings from initial and varimax rotated factor solutions also supported that the BTMS was unidimensional providing the evidence for construct validity of the BTMS. The single factor was named "Beliefs About the Teaching of Mathematics". Also, the experts checked content validity of the BTMS and the grammar of the test was checked by mathematics and literature teachers.

The alpha reliability coefficient of the BTMS with 42 items was found as 0.78 in the pilot study. The total score of BTMS was between 42 and 210.

BTMS was administered to 425 10^{th} grade high school students in rural areas of Ankara in the Spring Semester of the 2003-2004 academic years.

4.7 Procedure

The present study was conducted during 2003-2004 academic year at different kinds of high schools. The subjects of the study were asked items about their beliefs related to mathematics and the teaching of mathematics. The instruments were administered to students in their classrooms and in each class, the purpose of the study and the directions were explained. They were informed that there were no right or wrong answers to the items, the correct answer is his or her answer on the survey, and that their answers may be different from their classmates. The scales contained 22 items for BaMS and 42 items for BTMS that addressed students' beliefs about mathematics and the teaching of mathematics. The students completed the scales independently in approximately 30 minutes.

4.8 Data Analysis

Data analysis of the study was conducted by the following statistical techniques:

- Data of the present study were analyzed by using the SPSS package program.
- Data were coded, collected from the subjects by the following techniques:
  - students' responses to the survey items: strongly agree, agree, undecided, disagree and strongly disagree were coded from 5 to 1 respectively, then transfer them into computer environment with SPSS.
  - Anatolian high school, foreign language high school, general high school and vocational high school were coded from 4 to 1 respectively.
  - Lowachv, modachv and highachv were coded from 1 to 3 respectively into SPSS program.
  - Branches were coded vocational as 0, social as 1, math-literature as 2, and science as 3 for the analyses.
  - Gender was coded as1 for male and 2 for female.
- Reliability analysis was used to test the reliability of BaMS and BTMS scales administered in the present study.
- Descriptive statistics were used by the following reasons:
  - To get the mean, standard deviations, percentages and frequencies of the responses of each items on both BaMS and BTMS.
  - To find the distribution of the number and the frequencies of the subjects.
  - To detect the outliers and to check the data whether data recording error was made (data cleaning).

- MANOVA was used by the following reasons:
    - To determine whether there are significant mean differences among groups with respect to their beliefs about mathematics and the teaching of mathematics.
    - To test for interactions as well as for main effects to variables.
    - To examine the differences between all of the dependent variables simultaneously.

4.9 Assumptions and Limitations

In this section, assumptions and limitations of the present study are discussed.

4.9.1 Assumptions

The main assumptions of the present study are the following:

- There was no interaction between the subjects to affect the result of the present study.
- The subjects were able to understand and interpret the items truly.
- No outside event occurred during the study to affect the beliefs of the subjects.
- The administrations of the scales were completed under standard conditions.
- All subjects of the pilot and experimental studies answered the measuring instruments accurately and sincerely.

4.9.2 Limitations

The limitations of the present study are as listed below:

- This study was limited to subjects enrolled at the high schools in rural areas of Ankara during 2003-2004 academic years.
- The selection of subjects for the survey didn't comprise a random sampling. Therefore, the sample may not be fully representative of the population and generalizability is limited.
- Self-report techniques, which require the subject to respond truthfully and willingly, were used.
- For reaching the subjects' deep beliefs, the collection of data should include other methods like interviews. On the other hand, Kloosterman and Stage (1992) stated that the questionnaire method gives an appropriate result for the students' beliefs and this was one of the exact purposes of this study.

4.10 Validity of the Present Study

In this section internal and external validity of the study is discussed.

4.10.1 Internal Validity of the Present Study

Internal validity of a study means that observed differences on the dependent variable are directly related to the independent variable, but not due to some other unintended variable (Fraenkel & Wallen, 1996).

One possible threat to internal validity of a study is subject characteristics. In the present study, the students were at the same grade level so almost all the subjects' ages were very close to each other. The number of boys and girls was not equal but difference with respect to gender was considered as a variable and examined as a sub-problem. Hence, age and gender bias didn't affect research results unintentionally. Subjects' socioeconomic backgrounds, which may affect the results of a study, were almost the same in the present study.

Administering the questionnaires to all tenth-graders of each school almost at the same times controlled location threat.

Data collector characteristics and data collector bias wouldn't be threats in the present study because data collectors- the teachers, followed the same procedure, read the same instructions to all participating students.

It was remembered to students that their answers wouldn't be seen by anybody except the researcher and also wouldn't be used any other purposes except the present study. Thus, confidentiality was satisfied.

4.10.2 External Validity of the Present Study

External validity is the extent to which the results of a study can be generalized (Fraenkel & Wallen, 1996).

4.10.2.1 Population Validity

In the present study, convenience sampling was utilized. Because of this, generalizations of the findings of the study were limited. However, generalizations can be done on subjects having the same characteristics mentioned in the "Subjects of the Study" section.

4.10.2.2 Ecological Validity

The ecological validity is the degree to which results of a study can be extended to other setting or conditions (Fraenkel & Wallen, 1996). The measuring instruments were used in regular classroom settings. Since the study is on tenth grade high school students, the results of the present study can be generalized to similar settings to this study.

CHAPTER 5

RESULTS

In the previous chapters, the theoretical background of the study, the review of the previous studies and the method of the study were stated. This chapter contains two sections. The first section presents results of the testing hypotheses and the second section presents the overall pictures of students' responses about BaMS and BTMS.

5.1 Results of the Testing Hypotheses

One of the purposes of the present study was to investigate the beliefs of high school students about mathematics and the teaching of mathematics in terms of high schools, students' mathematics achievement level, branches and gender. The design of the present study is casual-comparative.

Hypotheses of the present study were tested at a significance level 0.05 on a five-point scale where 5 means "strongly agree", 4 means "agree", 3 means "undecided", 2 means "disagree", and 1 means, "strongly disagree".

To find out whether students' beliefs about mathematics and beliefs about the teaching of mathematics differ according to high schools, mathematics achievement level, branches and gender, a Multivariate Analysis of Variance (MANOVA) was computed by considering total scores of BaMS and BTMS as dependent variables. The results of the multivariate test of significance followed in the MANOVA procedure indicated that there is no significant interaction among the independent variables (see Table 5.1, $p>0.05$):

- There is no statistically significant interaction between gender and high school with respect to beliefs about mathematics and beliefs about the teaching of mathematics ($p>0.05$).

- There is no statistically significant interaction between gender and mathematics achievement level with respect to beliefs about mathematics and beliefs about the teaching of mathematics ($p>0.05$).
- There is no statistically significant interaction between mathematics achievement level and high school with respect to beliefs about mathematics and beliefs about the teaching of mathematics ($p>0.05$).
- There is no statistically significant interaction between gender, high school and mathematics achievement level with respect to beliefs about mathematics and beliefs about the teaching of mathematics ($p>0.05$).

5.1.1 Results of the Hypotheses of the First Problem

The first problem of the study is: " What are the beliefs of students who enrolled in the different kinds of high schools about mathematics and the teaching of mathematics?"

The hypotheses of the first problem are:

Ho1.1: 'There are no statistically significant differences among the mean scores of students who are enrolled to different kinds of high schools with respect to beliefs about mathematics (BaMS)"

Ho1.2: 'There are no statistically significant differences among the mean scores of students who are enrolled to different kinds of high schools with respect to beliefs about the teaching of mathematics (BTMS)."

To examine the first problem of the study, Ho1.1 and Ho1.2 were tested by Multivariate Analysis of Variance (MANOVA). It shows that there are overall statistically significant differences among the mean scores of students who enrolled to different kinds of high schools with respect to beliefs about mathematics and beliefs about the teaching of mathematics (Wilks' $\lambda=0.00$, p<0.05). To see where the difference occurs, the univariate F-test was performed. The results are given in Table 5.1.

Table 5.1 Results of "Univariate Analysis"

Source	Dependent variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Gender	BaMS	123.84	1	123.84	1.30	0.254
	BTMS	3137.10	1	3137.10	15.28	0.00*
High School	BaMS	4245.55	3	1415.18	14.89	0.00*
	BTMS	4545.11	3	1515.04	7.38	0.00*
MathAchvL	BaMS	6489.67	2	3244.84	34.14	0.00*
	BTMS	2705.26	2	1352.63	6.59	0.02*
Gender* High School	BaMS	380.42	3	126.87	1.33	0.263
	BTMS	472.82	3	157.61	0.77	0.513
Gender* MathAchvL	BaMS	370.07	2	185.04	1.95	0.144
	BTMS	374.99	2	187.49	0.91	0.402
High School* MathAchvL	BaMS	646.43	6	107.74	1.13	0.342
	BTMS	1337.59	6	222.93	1.09	0.370
Gender* High School* MathAchvL	BaMS	988.52	6	164.75	1.73	0.112
	BTMS	554.11	6	92.35	0.45	0.845
Error	BaMS	38116.06	401	95.05		
	BTMS	82352.59	401	205.37		
Total	BaMS	2544312.00	425			
	BTMS	10071124.00	425			

* p<0.05

As seen in Table 5.1, it was found that there are statistically significant differences among the mean scores of students who are enrolled to different kinds of high schools with respect to beliefs about mathematics ($p<0.05$) and there are statistically significant differences among the mean scores of students who are enrolled to different kinds of high schools with respect to beliefs about the teaching of mathematics ($p<0.05$).

To determine which groups caused the significant difference in beliefs about mathematics and beliefs about the teaching of mathematics scores, Tukey Test was employed. The results of the Tukey Test analysis related to the students' beliefs about mathematics and the teaching of mathematics at different high schools were showed in Table 5.2.

Table 5.2 The Results of The 'Tukey Test' related to the Stud ents' Beliefs about Mathematics and Teaching of Mathematics at Different High Schools

Dependent Variable	(I) High School	(J) High School	Mean Difference (I-J)	Sig.
BaMS	Vocational	General	-3.67	0.023*
		Foreign L.	-4.30	0.008*
		Anatolian	0.91	0.903
	General	Foreign L.	-0.63	0.966
		Anatolian	4.58	0.003*
	Foreign Language	Anatolian	5.21	0.001*
BTMS	Vocational	General	-4.71	0.062
		Foreign L.	-4.36	0.125
		Anatolian	2.28	0.649
	General	Foreign L.	0.35	0.998
		Anatolian	6.98	0.002*
	Foreign Language	Anatolian	6.63	0.007*

* $p<0.05$

According to Tukey Test results, it is seen that there are statistically significant differences among the mean scores of students who are enrolled to general high school and Anatolian high school with respect to beliefs about mathematics ($p<0.05$). In addition, there are statistically significant differences among the mean scores of students who are enrolled to general high school and vocational high school with respect to beliefs about mathematics ($p<0.05$). As seen in Table 5.3, students in general high school have higher BaMS scores than the students in Anatolian high school and vocational high school ($M_G=78.54$, $SD_G=10.49$; $M_A=73.96$, $SD_A= 12.73$; $M_V=74.87$, $SD_V=9.93$). Moreover, according the results, there are statistically significant differences among the mean scores of students who enrolled to foreign language high school and Anatolian high school with respect to beliefs about mathematics ($p<0.05$). In addition, there are statistically significant differences among the mean scores of students who are enrolled to foreign language high school and vocational high school with respect to beliefs about mathematics ($p<0.05$). As seen in Table 5.3, students in foreign language high school have higher BaMS scores than students in Anatolian and vocational high schools ($M_F=79.17$, $SD_F=9.67$; $M_A=73.96$, $SD_A= 12.73$; $M_V=74.87$, $SD_V=9.93$).

According to the Tukey Test results, there are statistically significant differences among the mean scores of students who are enrolled to general high school and Anatolian high school with respect to beliefs about the teaching of mathematics ($p<0.05$). In addition, there are statistically significant differences among the mean scores of students enrolled to foreign language high school and Anatolian high school with respect to beliefs about the teaching of mathematics. As seen in Table 5.3, students who are enrolled to general high school and foreign language high school have higher BTMS scores than students who are enrolled to Anatolian high school ($M_G=156.20$, $SD_G=16.29$; $M_F=155.85$, $SD_F=12.37$; $M_A=149.22$, $SD_A=15.62$).

As seen in Table 5.2, there are no statistically significant differences between the mean scores of students enrolled to Anatolian high school and vocational high school with respect to beliefs about mathematics and beliefs about the teaching of mathematics (p>0.05). In addition, there are no statistically significant differences between the mean scores of students who are enrolled to general high school and foreign language high school with respect to beliefs about mathematics and beliefs about the teaching of mathematics (p>0.05).

Table 5.3 Mean and Standard Deviations of the BaMS and BTMS Scores with respect to different kinds of high schools

High School	BaMS		BTMS	
	Mean	SD	Mean	SD
Anatolian	73.96	12.73	149.22	15.62
Foreign L.	79.17	9.67	155.85	12.37
General	78.54	10.49	156.20	16.29
Vocational	74.87	9.93	151.49	14.84

5.1.2 Results of the Hypotheses of the Second Problem

The second problem of the study is: "What are the beliefs of high school students who have the different mathematics achievement levels in terms of beliefs about mathematics and beliefs about the teaching of mathematics?

The hypotheses of the second problem are:

Ho2.1: "There are no statistically significant mean differences among students who have different mathematics achievement levels in terms of beliefs about mathematics."

Ho2.2: "There are no statistically significant mean differences among students who have different mathematics achievement levels in terms of beliefs about the teaching of mathematics."

Multivariate Tests show that there are overall statistically significant mean differences among students who have different mathematics achievement levels in terms of beliefs about mathematics and beliefs about the teaching of mathematics (Wilks' λ =0.00, $p<0.05$).

As seen in Table 5.1, It was found that there are statistically significant mean differences among students who have different mathematics achievement levels in terms of beliefs about mathematics ($p<0.05$) and there are statistically significant mean differences among students who have different mathematics achievement levels in terms of beliefs about the teaching of mathematics ($p<0.05$).

To find where the differences are, Tukey Test was done. The results of the Tukey Test analysis related to MathAchvL in terms of beliefs about mathematics and beliefs about the teaching of mathematics were showed in Table 5.4.

Table 5.4 The Results of The 'Tukey Test" related to MathAchvL in terms of Beliefs about Mathematics and Beliefs about the Teaching of Mathematics

Dependent variable	(I) MathAchvL	(J) MathAchvL	Mean Difference (I-J)	Sig.
BaMS	Lowachv	Modachv	-1.52	0.444
		Highachv	-7.96	0.00*
	Modachv	Highachv	-6.43	0.00*
BTMS	Lowachv	Modachv	-2.18	0.465
		Highachv	-4.88	0.005*
	Modachv	Highachv	-2.71	0.326

* $p<0.05$

According to the results, there are statistically significant mean differences among low and high achiever students in terms of beliefs about mathematics ($p<0.05$). In addition, there are statistically significant mean differences among high achiever and moderate achiever students in terms of beliefs about mathematics ($p<0.05$). As seen in Table 5.5, high achiever students have higher BaMS scores than low achiever and moderate achiever students (M_H=81.34, SD_H=10.25; M_L=73.39, SD_L=10.85; M_M=74.91, SD_M=9.45). In addition, as seen in Table 5.4, there are statistically significant mean differences among high achiever and low achiever students in terms of beliefs about the teaching of mathematics ($p<0.05$). Table 5.5 shows that high achiever students have higher mean scores than low achiever students with respect to beliefs about the teaching of mathematics (M_H=155.84, SD_H=15.69; M_L=150.96, SD_L=15.24). It was also found that there are no statistically significant mean differences among low achiever and moderate achiever students in terms of beliefs about mathematics and beliefs about the teaching of mathematics (see Table 5.4, $p>0.05$). In addition, there are no statistically significant mean differences among high achiever and moderate achiever students in terms of beliefs about the teaching of mathematics ($p>0.05$).

Table 5.5 Mean and Standard Deviations of the BaMS and BTMS Scores with respect to MathAchvL

MathAchvL	BaMS		BTMS	
	Mean	SD	Mean	SD
Highachv	81.34	10.25	155.84	15.69
Modachv	74.91	9.45	153.13	13.44
Lowachv	73.39	10.85	150.96	15.24

5.1.3 Results of the Hypotheses of the Third Problem

The third problem of the study is: "What are the beliefs of high school students who are in the different branches with respect to beliefs about mathematics and teaching of mathematics?

The hypotheses of third problem are:

Ho3.1: "There are no statistically significant mean differences among students who are in the different branches in terms of beliefs about mathematics."

Ho3.2: "There are no statistically significant mean differences among students who are in the different branches in terms of beliefs about the teaching of mathematics."

MANOVA results show that there are overall statistically significant mean differences among students who are in the different branches in terms of beliefs about mathematics and beliefs about the teaching of mathematics (Wilks' $\lambda=0.00$, $p<0.05$).

As seen in Table 5.6, It was found that there are statistically significant differences between the mean scores of students who are in the different branches with respect to beliefs about mathematics ($p<0.05$) and there are statistically significant differences between the mean scores of students who are in the different branches with respect to beliefs about the teaching of mathematics ($p<0.05$).

Table 5.6 The Results of the "Univariate Analysis" Related to Branch

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	Sig.
Branches	BaMS	9688.66	3	3229.55	33.11	0.00*
	BTMS	5210.04	3	1736.68	7.92	0.00*
Error	BaMS	41063.53	421	97.54		
	BTMS	92287.52	421	219.21		

* $p<0.05$

To find where the differences are, Tukey Test was done. The results of the Tukey Test analysis related to Branches in terms of beliefs about mathematics and beliefs about the teaching of mathematics were showed in Table 5.7.

Table 5.7 The Results of The 'Tukey Test" related to the Students' Beliefs about Mathematics and Teaching of Mathematics in Different Branches

Dependent Variable	(I) BRANCH	(J) BRANCH	Mean Difference (I-J)	Sig.
BaMS	Vocational	Social	6.29	0.00*
		Math-Literature	-1.63	0.551
		Science	-8.92	0.00*
	Social	Math-Literature	-7.92	0.00*
		Science	-15.21	0.00*
	Math-Literature	Science	-7.29	0.00*
BTMS	Vocational	Social	5.11	0.120
		Math-Literature	-3.33	0.274
		Science	-5.59	0.029*
	Social	Math-Literature	-8.43	0.001*
		Science	-10.70	0.00*
	Math-Literature	Science	-2.27	0.638

* $p<0.05$

According to the results, as seen in Table 5.7, there are statistically significant mean differences among science and social students in terms of beliefs about mathematics ($p<0.05$). In addition, there are statistically significant mean differences among science and vocational students in terms of beliefs about mathematics ($p<0.05$). Moreover, there are statistically significant mean differences among science and math-literature students in terms of beliefs about mathematics ($p<0.05$). As seen in Table 5.8, students who are at science branch have the highest BaMS scores ($M_{science}=83.79$, $SD_{science}=9.23$). In addition, as seen in Table 5.7, there are statistically significant mean differences among vocational and social students in terms of beliefs about mathematics ($p<0.05$). There are also statistically significant mean differences among math-literature and social students in terms of beliefs about mathematics ($p<0.05$). Table 5.8 shows that vocational students have higher BaMS scores than social students ($M_V=74.87$, $SD_V=9.93$; $M_{Social}=68.59$, $SD_{Social}=9.92$). In addition, math-literature students have higher BaMS scores than social students ($M_{M\text{-}L}=76.49$, $SD_{M\text{-}L}=10.24$; $M_{Social}=68.59$, $SD_{Social}=9.92$). Thus, social students have the least BaMS scores ($M_{Social}=68.59$, $SD_{Social}=9.92$; see Table 5.8). Moreover, there are no statistically significant mean differences among vocational and math-literature students with respect to beliefs about mathematics ($p>0.05$).

In addition, for BTMS scores, there are statistically mean differences between the vocational and science students; social and science students; social and math-literature students ($p<0.05$). Science students have higher BTMS scores than vocational and social students ($M_{science}=157.09$, $SD_{Science}=14.28$; $M_V=151.49$, $SD_V=14.84$; $M_{Social}=146.39$, $SD_{Social}=16.58$). In addition, math-literature students have higher BTMS scores than social students ($M_{M\text{-}L}=154.82$, $SD_{M\text{-}L}=14.31$; $M_{Social}=146.39$, $SD_{Social}=16.58$). In addition, there are no statistically mean differences between the vocational and social, vocational and math-literature, math-literature and science students in terms of beliefs about the teaching of mathematics.

Table 5.8 Mean and Standard Deviations of the BaMS and BTMS Scores with respect to Branches

Branch	BaMS		BTMS	
	Mean	SD	Mean	SD
Science	83.79	9.22	157.09	14.28
Math-literature	76.49	10.24	154.82	14.31
Social	68.59	9.92	146.39	16.58
Vocational	74.87	9.93	151.49	14.84

5.1.4 Results of the Hypotheses of the Fourth Problem

The fourth problem of the present study is: "What is the difference between girls and boys in terms of beliefs about mathematics and teaching of mathematics?"

The hypotheses of the fourth problem are:

Ho4.1: There is no statistically significant mean difference between the male and female students on beliefs about mathematics.

Ho4.2: There is no statistically significant mean difference between the male and female students on beliefs about the teaching of mathematics.

MANOVA test results (see Table 5.1) show that there is no statistically significant mean difference between the male and female students on beliefs about mathematics ($p=0.254>0.05$). On the other hand, it was found that there is statistically significant mean difference between the male and female students on beliefs about the teaching of mathematics ($p<0.05$). Table 5.9 shows that female students have higher BTMS scores than male students.

Table 5.9 Mean and Standard Deviations of the BaMS and BTMS Scores with respect to Gender

		Mean	SD
BaMS	Male	75.4225	11.9793
	Female	77.5210	9.9788
BTMS	Male	149.2139	14.6796
	Female	156.3151	14.8317

5.2 Overall Pictures of Students' Responses about BaMS and BTMS

In this section, students' responses to survey items were analyzed. While analyzing, frequency and percentages of the responses given to each item of BaMS and BTMS were taken into account (see Appendix C and D).

425 10th-grade students expressed varying degrees of strongly agree, agree, undecided, disagree, and strongly disagree with the item statements of BaMS and BTMS.

Results of the beliefs about mathematics scale (BaMS) and beliefs about the teaching of mathematics scale (BTMS) were tabulated by determining items upon which there was agreement, undecided and disagreement responses. The frequency and percentage of "agree" items were determined by summing strongly agree and agree responses, and the frequency and percentage of "disagree" items were determined by summing strongly disagree and disagree responses.

According to the results, there were strong agreements with the items BaMS 7 (88%), BaMS 20 (78%) and BaMS 22 (72%). These items are "mathematics help people to develop their problem solving abilities", "mathematics help people acquire logical thinking ability" and "mathematics is a tool that helps other branches of science develop". In addition, most students disagreed with the items BaMS 1 (74.6%) "mathematics has no effect on cognitive development" and BaMS 11 (68.9%) "mathematics is not need for society".

Moreover, most students believed (74%) that "the person who doesn't like mathematics can not do it." On the other hand, there was a strong agreement with the item BaMS 14 (90.4%) "people can have different mathematical ability".

Only the 53.9% students agreed, "mathematics is a subjects that concerns everybody".

Surprisingly, most of the students participated in the study (88.5%) agreed with the item "mathematics requires logic", on the other hand, only 43.1% students believed that "mathematics requires intuition".

Only 36.9% students believed that mathematics is an art like picture, poetry or music.

Most students agreed with the items BTMS 1 (71.1%) and BTMS 7 (70.4%) that are "it should be appreciated to applying mathematics in other areas" and "during teaching of mathematics, it should be tried to gain such abilities to us that we can establish connection between mathematics and other subject areas".

In the present study, most students agreed (82.8%) that it should be avoided from memorization in mathematics teaching. Similar results were taken from the items BTMS 2 (85%), BTMS 5 (78.8%), BTMS 9 (87.8%), BTMS 14 (82.6%) and BTMS 16 (73.1%) that are "why mathematics is thought must be explained", "it should be tried to gain abilities about expressing relationships among mathematics topics at mathematical class", "during teaching of mathematics, our problem solving ability should be developed by using different strategies", "it should be taken into account to "problem solving" method which consists of understand the problem, make a plan, applying a plan and control it" and "during teaching of rules at mathematics, how these rules were come from should be discovered to us". Similarly, 66.6% students disagreed with the item that "concepts should be memorized in the teaching of mathematic s".

Another important findings from the results that most students agreed with the items BTMS 17 (82.5%), BTMS 38 (84.5%) and BTMS 13 (78.9%) that "the teaching of mathematics should have quality to increase our self-confidence", "teaching of ma thematics shouldn't have a quality that cause fear toward mathematics", "teaching of mathematics should have a quality that change our visual angle toward positive side."

Most of the students disagreed with the items BTMS 3 (68%), BTMS 28 (61.2%) and agreed with the item BTMS 19 (83.6%) that are related to the teacher's role in learning to mathematics.

The percentage of students who agreed that mathematics was mostly understood by studying together was generally high (76.7%).

There was a strong agreement with the item BTMS 40 (87.1%) that were related to learning mathematics by using practical ways.

The items BTMS 22, BTMS 24, BTMS 27 and BTMS 30 that are related to learning mathematics by using concrete materials such as computer, calculator and overhead projector have not high agree or disagree responses. Only 67% students disagreed with the item BTMS 24 (During teaching of mathematics, it shouldn't be used concrete materials). Similar results were taken from the items BTMS 22, BTMS 27 and BTMS 30. 39.3% of the students agreed that it should be permitted to use calculators, 59.7% of the students agreed that computer should be used in teaching of mathematics and 42.3% of the students disagreed that projector shouldn't be used in teaching of mathematics.

The items that are related to real life examples about math topics are BTMS 29 and BTMS 39. The percentages of these items were not high. That is, only 54.3% of the students agreed with the item BTMS 29 and 55.8% of the students agreed with the item BTMS 39.

CHAPTER 6

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents discussions and conclusions related to the results reported in the previous chapter, and recommendations are stated.

6.1 Discussion

Students' beliefs about mathematics and learning to mathematics have been studied by several researchers and educators to make sense of their mathematical behavior. In the present study, it was investigated the students' beliefs about mathematics and the teaching of mathematics. In order to accomplish this, students' beliefs about mathematics and the teaching of mathematics were analyzed according to the percentages of the students' responses to each item. To investigate their beliefs with respect to high schools, branches, mathematics achievement level and gender, hypotheses were tested by MANOVA. In this section results of the study will be discussed.

According to MANOVA results, there were statistically significant differences among the mean scores of students who were enrolled to different kinds of high schools with respect to beliefs about mathematics and beliefs about the teaching of mathematics. Thus, it could be stated that students at different high schools had different beliefs about mathematics and the teaching of mathematics. This result might occur because of external factors. These external factors could be the structure of the classrooms and mathematics instruction. These results seemed to be related to the results of which differs in the classroom environment and experiences might have influenced the students' motivation and achievement that influence students' beliefs (Midgley, Feldlaufer & Eccles, 1989; Aksu, Demir & Sümer, 2002). Surprisingly, when we look at the mean scores, it can be seen that students enrolled to foreign language high school had the highest mean scores, on the other hand, students in Anatolian high school had the least mean scores with respect to beliefs about mathematics and beliefs about the teaching of mathematics. Students in Anatolian high school could be expected to get high mean scores than students in other schools. But in this study, this result couldn't be found. This might be occurred because this school was in rural areas and students' scores who entered this school were lower than students enrolled to other Anatolian high schools in urban areas.

When we take into consideration the results related to students' mathematics achievement level, it could be easily seen that there was a significant difference between the students with different achievement levels. Students who had high achievement received high score from the scales on beliefs about mathematics and beliefs about the teaching of mathematics. Students who succeed in mathematics could see it as an important, useful and necessary tool for other subjects and also for real life. Inversely, students who believed that mathematics was an important subject may have high motivation resulting in achievement. This result seemed to be related to beliefs that were important with respect to student motivation to learn mathematics (Kloosterman, 1999) and increasing students' beliefs about usefulness to learn mathematics was related to increasing motivation and thus achievement (Kloosterman & Stage, 1992). Moreover, the difference in beliefs of students with respect to achievement might be the reason of self-confidence. According to Eynde and Corte (2003), students who were confident about their mathematical ability were mostly also the ones who were convinced about the relevance of mathematics; similarly, students with low self-confidence were also not convinced of the importance of mathematics.

Another important findings from the results that students who were in different branches had different beliefs about mathematics and the teaching of mathematics. According to the results, science students had the highest BaMS and BTMS mean scores, whereas social students had the least mean scores. Science students took more mathematics courses than the other students who were in social, vocational and math-literature branches, on the other hand, social students didn't take any mathematics courses (see Appendix E). Students who had taken a variety of mathematics courses might be expected to have differing beliefs about mathematics and the teaching of mathematics. According to Kloosterman and Stage (1992), this wouldn't be surprising. Moreover, this difference might occur because of willing to enroll in mathematics courses. Kloosterman and Stage (1992) also stated that while intent to enroll in mathematics courses might be related to increasing beliefs about learning mathematics.

In the present study, it was also found that there was no statistically significant mean difference between the male and female students on beliefs about mathematics. The result is consistent with the findings of Eccles et al (1993) who stated that girls and boys valued mathematics equally. In addition, Aksu, Demir and Sümer, (2002), and Baydar (2000) found no statistically mean difference between male and female students in terms of beliefs about mathematics. In the present study, it could be also stated that students both male and female thought that mathematics was an important subject to learn. According to the results of Vanayan, White, Yuen and Teper (1994)' study , there was no gender difference that they had need to know mathematics in order to get a good job and also overwhelming majority of students indicated that both girls and boys should learn mathematics. In the present study, it was also found that female students had higher mean scores than male students in terms of beliefs about the teaching of mathematics. This difference could be occurred since female students had more tendency to take different teaching methods than male students.

According to Schoenfeld (1985), many students appear to hold a lot of beliefs about mathematics. Also, Kloosterman and Stage (1992) noted that students had varying beliefs about mathematics as a subject and about the individual as a learner of mathematics. These are valid for students in the present study. These were discussed in the following:

When we look at the percentages of the responses to the items- "mathematics help people to develop their problem solving abilities", "mathematics help people acquire logical thinking ability", and "mathematics is a tool that helps other branches of science develop", we could infer that most students believed that mathematics was useful and important subject. This result is consistent with the findings of a study carried out by Fleener (1996). He stated that believing to know 'mathematics profit all students' and 'mathematics develop good reasoning ability' suggested students valued learning to mathemati cs.

In addition, most students disagreed with the items "mathematics has no effect on cognitive development" and "mathematics is not needed for society". This result is consistent with the findings of Aksu, Demir and Sümer (2002) that they found that most students believed the usefulness and relevance of mathematics outside of school.

According to the results, most students believed that the person who did not like mathematics could not do it. Thus, they might think that being successful in mathematics required liking it. On the other hand, there was a strong agreement that "people could have different mathematical ability". Thus, they might also think that their success or failure could be related to their mathematical ability.

Most of the students participated in the study (88.5%) agreed with the item "mathematics requires logic", thus, students might think that mathematics had the rules that follow logical series and only 43.1% of the students who believed that mathematics required intuition could suggest chance was not an important role for their success or failure in mathematics.

Most students agreed that "it should be appreciated to applying mathematics in other areas" and "during teaching of mathematics, it should be tried to gain such abilities to us that we could establish connection between mathematics and other subject areas". It could be said that students might be aware of a relation between learning mathematics and learning other subjects. Similar results were reported by Vanayan, White, Yuen and Teper (1997) and they stated that students appeared to believe the integrating view of learning. On the other hand, in the present study, only 36.9% students believed that mathematics was an art like picture, poetry or music. According to the results of the study carried out by Vanayan, White, Yuen and Teper (1997), only about 20% of students indicating the learning mathematics was mostly like learning either language or art. These results might occur because of thinking mathematics as a computing numbers.

Kloosterman (1999) stated that students tended to feel that memorization, and the ability to memorize were important part of being successful in mathematics. On the other hand, in the present study, most students agreed that it should be avoided from memorization in mathematics teaching. Thus, this result showed that students might think memorization was not a good method for learning mathematics. On the other hand, in spite of believing memorization shouldn't be used in learning to mathematics, they usually memorize the rules as well as the ways that are used to solve problems. Teacher's role and the mathematics curriculum might be the one of the reasons. In schools, however, mathematics is still taught by using lecturing method. That is, teacher gives knowledge and students take it. They don't need to think, discover and use their creativity. They just learn what they are taught. Thus, in this education system, students get difficulties with different problems requiring thinking, questioning, discovering and investigating. Finally, they simply memorize the rules to answer the questions.

Most of the students agreed with the items that were "why mathematics was taught had to be explained", "it should be tried to gain abilities about expressing relationships among mathematics topics at mathematical class", "during teaching of mathematics, our problem solving ability should be developed by using different strategies", " it should be taken into account to 'problem solving' techniques which consist of understand the problem, make a plan, applying a plan and control it" and "during teaching of rules at mathematics, how these rules were come from should be discovered to us". Thus, students might feel that mathematics could be learned if it was taught by using method that includes discovering, integrating other topics, expressing their own ideas, and organizing information. That is, students might want to be a part of the teaching of mathematics.

Another important findings from the results, most students agreed that the teaching of mathematics should have quality to increase their self-confidence, teaching of mathematics shouldn't have a quality that cause fear toward mathematics, and teaching of mathematics should have a quality that change their visual angle toward positive side. This result might show that students seemed to self-confidence as an important part of learning mathematics.

According to the results of the present study, most students believed that teacher was an important part of the learning to mathematics. In addition, they also believed that mathematics could be learning by studying together (76.7%). On the other hand, according to the results, learning mathematics by using concrete materials such as computer, calculator, and overhead projector had no high agree or disagree responses: 39.3% of the students agreed that it should be permitted to use calculators, 59.7% of the students agreed that computer should be used in teaching of mathematics and 42.3% of the students disagreed that projector shouldn't be used in teaching of mathematics. These might be result of the method used in classes. Generally, lecturing method could be used to learning mathematics in schools so students could not use any materials in their classes during teaching-learning process. Thus, they might not be aware of usefulness and capabilities of these concrete materials.

Moreover, the percentages of the items related to learning mathematics by giving real life examples were not high. This result might be occurred because of thinking mathematics as a subject that was not part of the real life and finding difficulty to give real life examples related to mathematics topics.

6.2 Conclusions

The main problem of the present study is 'what are the students' beliefs about mathematics and the teaching of mathematics."

In this section, in the light of the findings obtained by statistical testing of each hypothesis, the following conclusions can be stated:

1. There are statistically significant differences among the mean scores of students who are enrolled to different kinds of high schools with respect to beliefs about mathematics and beliefs about the teaching of mathematics:

- There are statistically significant differences among the mean scores of students who are enrolled to general high school and Anatolian high school with respect to beliefs about mathematics and beliefs about the teaching of mathematics.
- There are statistically significant differences among the mean scores of students who are enrolled to general high school and vocational high school with respect to beliefs about mathematics.
- There are statistically significant differences among the mean scores of students who are enrolled to foreign language high school and Anatolian high school with respect to beliefs about mathematics and beliefs about the teaching of mathematics.
- There are statistically significant differences among the mean scores of students who are enrolled to foreign language high school and vocational high school with respect to beliefs about mathematics.
- There are no statistically significant differences between the mean scores of students who are enrolled to Anatolian high school and vocational high school with respect to beliefs about mathematics and beliefs about the teaching of mathematics.
- There are no statistically significant differences between the mean scores of students who are enrolled to general high school and foreign language high school with respect to beliefs about mathematics and beliefs about the teaching of mathematics.

- Students in foreign language high school have the highest mean scores with respect to beliefs about mathematics and the teaching of mathematics, whereas, students in Anatolian high school have the least mean scores with respect to beliefs about mathematics and the teaching of mathematics.

2. There are statistically significant mean differences among students who have different mathematics achievement levels in terms of beliefs about mathematics and beliefs about the teaching of mathematics:

- There are statistically significant mean differences among low and high achiever students in terms of beliefs about mathematics and beliefs about the teaching of mathematics.
- There are no statistically significant mean differences among low achiever students and moderate achiever students in terms of beliefs about mathematics and beliefs about the teaching of mathematics.
- There are statistically significant mean differences among high achiever and moderate achiever students in terms of beliefs about mathematics.
- High achiever students have the highest mean scores, whereas, low achiever students have the least mean scores with respect to beliefs about mathematics and the teaching of mathematics.

3. There are statistically significant mean differences among students who are in the different branches in terms of beliefs about mathematics and the beliefs about the teaching of mathematics:

- There are statistically significant mean differences among math-science and social students in terms of beliefs about mathematics and beliefs about the teaching of mathematics.

- There are statistically significant mean differences among math-science and vocational students in terms of beliefs about mathematics and beliefs about the teaching of mathematics.
- There are statistically significant mean differences among math-science and math-literature students in terms of beliefs about mathematics.
- There are no statistically significant mean differences among math-literature and vocational students in terms of beliefs about mathematics and beliefs about teaching of mathematics.
- Science students have the highest mean scores, whereas, social students have the least mean scores with respect to beliefs about mathematics and the teaching of mathematics.

4. There is no statistically significant mean difference between the male and female students on beliefs about mathematics. On the other hand, it was found that there is statistically overall significant mean difference between the male and female students on beliefs about the teaching of mathematics in the favor of female students.

In the present study, students' responses to survey items were also analyzed by using percentages of the answers given to each item of BaMS and BTMS. According to the results, it was concluded that most students believed that

- Mathematics was useful and important subject.
- There was a relation between learning mathematics and learning other subjects.
- Memorization is not good method for learning mathematics.
- Teacher was an important part of the learning to mathematics.
- Mathematics could be learned by studying together.

- Mathematics requires logic.
- Mathematics help people to develop their problem solving abilities.
- Teaching of mathematics should have quality to increase their self-confidence and change their visual angle toward positive side.
- Mathematics should be taught by using practical ways to find the solution quickly.

6.3 Recommendations

The present study gives an idea about what the students had beliefs about mathematics and the teaching of mathematics. This provides us to learn how students want to be taught to mathematics.

First of all, teachers should be well educated in Turkey. The beliefs of students should become a matter of concern for teacher education programs and how different and effective teaching methods are used in classrooms should be taught to preservice teachers.

Moreover, according to the results of the present study, most students were not be aware of usefulness and importance of the concrete materials such as calculator, computer and projector in learning to mathematics. In Turkey, mathematics curriculum is very loaded and thus there may be no time to apply some different techniques in classes. Thus, curriculum should include such techniques that let students use and apply these concrete materials more adequately. In addition, mathematics teachers should be educated how these materials can be used effectively in learning to mathematics.

According to the results, some students believed that "mathematics is not need for society", "there is no room for creativity in mathematics" or "mathematics has no effect on cognitive development". To change students' beliefs about mathematics and the teaching of mathematics in the direction of suggestions from the literature, mathematics teacher should

- make sure that students have opportunities to set end give their ideas independently.
- explain importance of learning mathematics.
- give daily life examples related to mathematics topics.
- give opportunities to students to use concrete materials such as calculator and computer.
- encourage students for creativity thinking.
- help students see connections among concepts.
- do small group discussions to obtain information about students' beliefs related to mathematics and the teaching of mathematics.

According to the results of the present study, in teacher education programs, preservice teachers must have competency on

- how to teach mathematics in a way that children can understand and apply it to other subject areas and real life, and realize the relationship among mathematics concepts.
- how to use concrete materials such as computer and calculator to teach some mathematical concepts.
- how to apply teaching methods that include discovering, integrating, analyzing and sharing the ideas in classes effectively.

According to the results of the present study, while developing mathematics curriculum, the followings must be taken into consideration:

- reasoning so that students can use relationships to explain their thinking and believe that mathematics makes sense.
- investigations of mathematical connections so that students can use mathematics in their daily life.
- opportunities for communication so that students can reflect on and clarify their ideas about mathematical concepts.

- some skills so that students can use facts, properties, and relationships to explain their thinking.

In the present study it is intended to provide an idea about the beliefs of high school students about mathematics and the teaching of mathematics. This subject requires more detailed research studies.

In the light of the present study, the researchers can investigate the following areas:

- the relation between belief and achievement.
- the relation between belief and such variables that affect the achievement: anxiety, self-confidence, motivation.
- the sample size can be increased in further studies. To be able to talk about Turkey overall, subjects from different schools of different geographical regions should be selected.
- for a deep investigation of students' beliefs, qualitative methods of research can be utilized.
- beliefs of students at different grade levels can be searched for.
- Students' beliefs about other subject areas such as biology, physics or chemistry can be investigated.

REFERENCES

Aksu, M., Demir, C.E., Sümer, Z.H., (2002). Students' Beliefs About Mathematics: A Descriptive Study. *Education and Science*, Vol.27, No: 123, 72-77.

Austin, S. & Wadlington, E., (1992). Effect of Beliefs About Mathematics on Math Anxiety and Math Self-Concept in Elemantary Teachers. *Education*, 112(3), 390-397.

Ball, D. L., (1988). Unlearning to Teach Mathematics. *For the Learning of Mathematics*, 8(1), 40-48.

Baydar, C. (2000). Beliefs of Pre-service Mathematics Teachers at the Middle East Technical University and the Gazi University about the Nature of Mathematics and the Teaching of Mathematics. Unpublished Master' Thesis. Middle East Technical University.

Brown, C. A. & Cooney, T. J. (1982). Research on Teacher Education: A Philosophical Orientation. *Journal of Research and Development in Education*, 15(4), 13-18.

Corte, E. D. & Eynde, P. O., (2003). Students' Mathematics -Related Belief Systems: Design and Analysis of a Questionnaire. Eric No: ED 475708.

Dewey, J. (1933). How we think. In M. F. Pajares (Ed) (1992). Teachers' Beliefs and Educational Research: Cleaning Up a Messy Construct (pp 313). *Review of Educational Research*, 62(3), 307-332.

Eccles, J.S., Wigfield, A., Harold, R. & Blumenfeld, P., (1993). Age and Gender Differences in Children's Achievement Self -Perceptions During the Elemantary School Years. *Child Development.*

Ernest, P. (1989). The Knowledge, Beliefs and Attitudes of the Mathematics Teacher: A Model. *Journal of Education for Teaching*, 15, 13-34.

Eynde, P.O., Corte, E. & Verschaffel, L. (1999). Balancing Between Cognition and Affect: Students' Mathematics -related Beliefs and Their Emotions during Problem Solving. In E. Pehkonen & G. Törner (Eds). (pp 97-103)

Fleener, J., (1996). Scientific World Building on the Edge of Chaos: High School Students' Beliefs About Mathematics and Science. *School Science and Mathematics*, 96(6), 312-320.

Frank, M. L., (1988). Problem Solving and Mathematical Beliefs. *Arithmetic Teacher,* 35 (5), 32-34.

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

Gonske, T., (2002). Relationships Among Mathematics Anxiety, Beliefs About the Nature of Mathematics and The Learning Approaches in Non-Traditional Aged Students at the Community College, University of Northern Colorado, UMİ No: 3059983.

Green, T. F. (1971). The Activities of Teaching. In D. A. Grouws (Ed) (1992). Handbook of Research on Mathematics Teaching and Learning, (pp 127-146). New York: Macmillan Puplishing Company

Hersh, R. (1986). Some Proposals for Revising the Philosophy of Mathematics. In D.A. Grouws (Ed.) (1992). Handbook of Research on Mathematics Teaching and Learning, (pp 127-146). New York: Macmillan Puplishing Company

Harvey, O. J. (1986). Belief Systems and Attitudes Toward the Death Penalty and Other Punishments. *Journal of Psychology*, 54, 143-159.

Hiebert, J. (1984). Children's Mathematical Learning: The Struggle to Link Form and Understanding. *Elementary School Journal*, 84(5), 497-513.

Kloosterman, P. & Stage, F., (1992). Measuring Beliefs About Mathematical Problem Solving. *School Science and Mathematics*, 92(3), 109-115.

Kloosterman, P., (1999). Mathematical Beliefs and Motivation of High School Students in the United States. In E. Pehkonen & G. Törner (Eds). *Mathematical beliefs and their impact on teaching and learning of mathematics: Proceedings of the workshop in Oberwolfach,* (pp. 50-56). Duisburg, Germany: Gerhard Mercator Universität Duisburg.

Lester, F. K., Garofalo, J. & Kroll, D. L. (1989). Self Confidence, Interest, Beliefs and Metacognition: Key Influences on Problem Solving Behavior.

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

National Council of Teachers of Mathematics (1989). Curriculum and Evaluation Standards for School Mathematics.

Nespor, J. (1987). The Role of Beliefs in the Practice of Teaching. *Journal of Curriculum Studies*, 19, 317-328.

Pajares, M. F., (1992). Teachers' Beliefs and Educational Research: Cleaning Up a Messy Construct. *Review of Educational Research*, 62(3), 307-332.

Pehkonen, E. & Tompa, K., (1994). Pupils' Conceptions About Mathematics Teaching in Finland and Hungary. *International Journal of Mathematics Education and Science Technology*, 25(2), 229-238.

Pehkonen, E. & Törner, G., (1999). Mathematical beliefs and their impact on teaching and learning of mathematics: Proceedings of the workshop in Oberwolfach. Duisburg, Germany: Gerhard Mercator Universität Duisburg.

Rokeach, M., (1968). Beliefs, Attitudes and Values. In M.F. Pajares (Ed), (1992). Teachers' Beliefs and Educational Research: Cleaning Up a Messy Construct. *Review of Educational Research*, 62(3), 307-332.

Scheffler, I., (1965). Conditions of Knowledge : An Introduction to Epistemelogy and Education. Teachers' Beliefs and Conceptions: A Synthesis of the Research. In D. A. Grouws (Ed) (1992). Handbook of Research on Mathematics Teaching and Learning, 127-146. New York: Macmillan Puplishing Company

Schoenfeld, A. H., (1985). Mathematical problem Solving. Orlando, Florida: Academic Press.

Schoenfeld, A. H., (1989). Explorations of Students' Mathematical Beliefs and Behavior. *Journal for Research in Mathematics Education*, 20(4), 338-355.

Schommer, M., (1990). Effects of Beliefs About the Nature of Knowledge on Comprehension. *Journal of Educational Psychology*, Vol.82, No.3, 498-504.

Sigel, I.E., (1985). A Conceptual Analysis of Belief. In E. Sigel (Ed.), Parental Belief Systems: The Psychological Consequences of Children, 345-371.

Spangler, D. (1992). Assesing Students' Beliefs About Mathematics. *The Mathematics Educator*. V(3), N1, 19-25.

Steele, D. F. & Widman, T.F., (1997). Practitioner's Research: A study in changing preservice teachers' conceptions about mathematics. *School Science and Mathematics*, 97 (4), 184-190.

Stipek, D. J. & Gralinski, J. H. (1991). Gender Differences in Children's Achievement-Related Beliefs and Emotional Responses to Success and Failure in Mathematics. *Journal of Educational Psychology*. Vol 83, No.3, 361-371.

Thompson, A.G., (1992). Teachers' Beliefs and Conceptions: A Synthesis of the Research. In D.A. Grouws. Handbook of Research on Mathematics Teaching and Learning, (pp 127-146). New York: Macmillan Puplishing Company.

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.

APPENDIX A

Adınız Soyadınız:.. Cinsiyetiniz: ....

Okulunuzun çeşidi aşağıdakilerden hangisidir?
a)Genel Lise b)Anadolu Lisesi c)Meslek Lisesi d)Yabancı Dil Ağırlıklı Lise

Bölümünüz nedir? a) Matematik-Fen b) Türkçe-Matematik c) Sosyal

Geçen yılki matematik karne notunuz nedir? a) 5 b) 4 c) 3 d) 2 e) 1 f) 0

BÖLÜM I: MATEMATİK İNANÇ ÖLÇEĞİ

Yönerge: Aşağıda matematikle ilgili 22 inanç cümlesi bulunmaktadır. Bu cümleler, ifade edilen düşüncelere sizin ne derece katılıp katılmadığınızı belirtmenize olanak verecek şekilde düzenlenmiştir. Doğru yada yanlış cevap bulunmamaktadır. Yalnızca sizin doğru bulduğunuz cevaplar doğru kabul edilmektedir. Sözgelimi cümle şöyle:

Örnek: Matematik bir dildir.

Böyle bir cümleyi okuduğunuzda bu düşünceye katılıp katılmadığınızı biliyor olacaksınız. Eğer bu düşünceye kesinlikle katılıyorsanız cevap olarak "kesinlikle katılıyorum" seçeneğini işaretleyiniz. Eğer sadece katılıyorsanız "katılıyorum" seçeneğini işaretleyeceksiniz. Eğer cümlede belirtilen düşünceye katılmıyorsanız, nederece katılmadığınızı göstermek için; düşünceye sadece katılmamanız durumunda "katılmıyorum" seçeneğini, kesinlikle karşı olmanız durumunda "hiç katılmıyorum" seçeneğini işaretleyiniz. Fakat, ifade edilen düşünce hakkında olumlu ya da olumsuz bir görüş belirtmiyorsanız, yani, kararsızsanız "kararsızım" seçeneğini işaretleyiniz. Mümkün olduğunca, yaşadıklarınızı düşünerek karar veriniz. Sizin görüşleriniz bizim için çok önemlidir. **Verdiğiniz cevaplar sadece araştırma amaçlı kullanılacaktır.** Lütfen her bir cümleyi dikkatlice okuyarak **boş bırakmadan size en uygun olan tek seçeneği** (**X**) ile işaretleyin. Katkılarınız için çok teşekkürler.

Table A1 Matematik İnanç Ölçeği Maddeleri

	Kesinlikle Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç Katılmıyorum
1)Matematiğin, zihinsel gelişmeye etkisi yoktur.					
2) Matematik bir dildir.					
3) Matematiği sevmeyen insan yapamaz.					
4) Matematik her insan için ilgilenmeye değer bir konudur.					
5) Her insana matematik öğretilemez.					
6)Matematik doğal olayları sayılarla açıklayan bir bilimdir.					
7)Matematik, problem çözme becerisini geliştirir.					
8)Matematik, resim, şiir ve müzik gibi bir sanattır.					
9)Matematik, sadece sayılarla uğraşan bir bilimdir.					
10) Matematik, insanların hayatta karşılaştıkları problemleri çözerken geliştirdikleri bir düşünme biçimidir.					
11) Matematik, toplum için bir ihtiyaç değildir.					
12) Matematik hayatı kolaylaştırır.					

Table A1 (continued)

	Kesinlikle Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç Katılmıyorum
13) Matematik, uygarlığın gelişimi için kullanılan bir araç değildir.					
14) Kişilerin matematiksel kabiliyetleri farklı olabilir.					
15) Matematikte mantık gereklidir.					
16)Matematik için kuvvetli bir hafızaya gerek yoktur.					
17)Matematikte sezgi gereklidir.					
18) Matematikte doğru cevabın bulunması en önemli mesele değildir.					
19) Matematikte yaratıcılığın yeri yoktur.					
20) Matematik mantıksal düşünmenin kazandırılmasında yardımcı olur.					
21) Matematik bir oyundur.					
22) Matematik diğer bilim dallarının gelişmesine katkıda bulunan bir araçtır.					

APPENDIX B

BÖLÜM II: MATEMATİK ÖĞRETİMİ İNANÇ ÖLÇEĞİ

Yönerge: Aşağıda matematik öğretimi ile ilgili 42 inanç cümlesi bulunmaktadır. "**BÖLÜM I**" deki açıklamalar bu bölüm için de geçerlidir. Lütfen, her bir cümleyi dikkatlice okuyarak boş bırakmadan size en uygun olan **tek bir seçeneği** (**X**) ile işaretleyiniz. **Verdiğiniz cevaplar sadece araştırma amaçlı kullanılacaktır.**

Table B1 Matematik Öğretimi İnanç Ölçeği Maddeleri

	Kesinlikle Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç Katılmıyorum
1)Matematiğin diğer alanlardaki uygulamalarına değer verilmelidir.					
2) Matematiğin neden öğretildiği açıklanmalıdır.					
3) Matematiğin anlaşılmasını sağlamak öğretmenin sorumluluğu değildir.					
4) Sonucun tahmin edilmesine önem verilmelidir.					
5) Matematik dersinde, matematik konuları arasındaki ilişkileri ifade edebilme becerilerinin kazandırılmasına çalışılmalıdır					
6) Tamamlanan çözümün 'sağlamasını' yapma becerisi kazandırmak gereksizdir.					

Table B1 (continued)

	Kesinlikle Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç Katılmıyorum
7) Matematik öğretimi sırasında, matematik ve diğer alanlar arasında bağlantı kurabilme becerilerimizin kazandırılmasına çalışılmalıdır.					
8) Matematikte ezber yönteminden kaçınılmalıdır.					
9) Matematik öğretimi sırasında, farklı stratejiler kullanılarak problem çözme becerilerimizin geliştirilmesine çalışılmalıdır.					
10) Matematik öğretiminin bir amacı da matematiksel yeteneklerimizin geliştirilmesi olmalıdır.					
11) Gerçek hayattan alınan problemlerin çözülmesi üzerinde fazla durulmamalıdır.					
12) Matematiksel düşünce şeklinin öğretilmesine önem verilmelidir.					
13) Matematik öğretimi, matematiğe karşı bakış açılarımızı olumlu yönde değiştirici nitelikte olmalıdır.					
14) Problemi anlama, plan kurma, planı uygulama ve kontrol etme aşamalarını içeren "problem çözme" yöntemine önem verilmelidir.					

Table B1 (continued)

	Kesinlikle Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç Katılmıyorum
15) Matematik öğretiminde kavramlar ezberletilmelidir.					
16) Matematikteki kurallar öğretilirken, bunların nasıl elde edildiği bizlere keşfettirilmelidir.					
17)Matematik öğretimi, matematik konusunda kendimize olan güveni arttırıcı nitelikte olmalıdır.					
18) Matematikle ilgili gerçek hayattan örnekler bulmak zordur.					
19) Matematik öğretmeninin,konuyla ilgili fikirlerimize değer verip, bunları dinlemesi gerekir.					
20) Sınıfta fikirleri matematiksel dille ifade etmeye gerek yoktur.					
21) Matematik dersinde,sınıfta çözülen problemlerden, yeni problemler üretebilecek duruma gelmemiz gerekir.					
22) Matematik dersinde hesap makinelerinin kullanımına izin verilmelidir.					

Table B1 (continued)

	Kesinlikle Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç Katılmıyorum
23) Birlikte çalışılarak matematik daha iyi anlaşılır.					
24) Matematik öğretilirken somut materyaller kullanılmamalıdır.					
25)Matematiğin toplumdaki ve diğer alanlardaki değeri, uygulama alanları gösterilerek öğretilmelidir.					
26) Matematik öğretilirken, farklı öğretim yöntemleri kullanılmalıdır.					
27) Matematik öğretiminde bilgisayardan faydalanılmalıdır.					
28)Öğretmen, matematiği sevmese de iyi öğretebilir.					
29)Matematik, günlük hayattan örnekler verilerek anlatılmalıdır.					
30) Matematik öğretiminde tepegöz kullanılmamalıdır.					
31) Matematik sadece, derste öğretmen anlatırsa öğrenilir.					
32) Öğretmen, matematiği öğretirken tartışma yönteminden de faydalanmalıdır.					

Table B1 (continued)

	Kesinlikle Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç Katılmıyorum
33)Tiyatro oyunu oynayarak öğrenme tekniği matematik konularını öğrenmemizde olumlu katkıları vardır.					
34) Matematikte yaygın olarak kullanılan sembollerin yanında, bizlerin önerdiği semboller de kullanılmalıdır.					
35) Matematiğin daha iyi anlaşılabilmesi için grafikler, şekiller ve tablolar kullanılmalıdır.					
36) Matematik öğretilirken, öğretilen konunun tarih içindeki gelişim süreci anlatılmalıdır.					
37) Matematik dersinde kendi başımıza matematiği nasıl öğrenebileceğimiz öğretilmelidir.					
38) Matematik öğretimi, matematik korkusu oluşturucu nitelikte olmamalıdır.					
39) Matematik, gerçek yaşantıdan benzetme yapılarak öğretilmelidir.					
40) Konuların yanı sıra sorular çözülürken kullanabilecek kısa ve pratik yollar öğretilmelidir.					
41) Matematik dersinde konu ile ilgili ünlü matematikçilerden söz edilmemelidir.					
42) Çeşitli projeler hazırlamak, matematiği öğrenmede katkı sağlar.					

APPENDIX C

Table C.1 Percentages and Frequencies of Responses Given to Each Item of BaMS

Item	Agree	Undecided	Disagree
BaMS1	16.4%(72)	8.5% (36)	74.6% (317)
BaMS 2	45.7% (194)	22.4% (95)	32% (136)
BaMS 3	74.1% (315)	6.8% (29)	19% (81)
BaMS 4	53.9% (229)	17.4% (74)	28.7% (122)
BaMS 5	62.6% (266)	16.7% (71)	20.8% (88)
BaMS 6	48% (204)	23.3% (99)	28.7% (122)
BaMS 7	88% (374)	3.8% (16)	8.2% (35)
BaMS 8	36.9% (157)	17.6% (75)	45.4% (193)
BaMS 9	40.2% (171)	14.1% (60)	45.7% (194)
BaMS 10	53.2% (226)	22.4% (95)	24.4% (104)
BaMS 11	21.6% (92)	9.4% (40)	68.9% (293)
BaMS 12	64.2% (273)	10.8% (46)	25% (106)
BaMS 13	21.9% (93)	28.5% (121)	49.7% (211)
BaMS 14	90.4% (384)	4.7% (20)	5% (21)
BaMS 15	88.5% (376)	5.6 % (24)	5.8% (25)

Table C.1 (continued)

Item	**Agree**	**Undecided**	**Disagree**
BaMS 16	41.7% (177)	20.7% (88)	37.7% (160)
BaMS 17	43.1% (183)	32% (136)	25% (106)
BaMS 18	49.2% (209)	18.8% (80)	32% (136)
BaMS 19	24.2% (103)	22.4% (95)	53.4% (227)
BaMS 20	77.9% (331)	12.2% (52)	9.9% (42)
BaMS 21	53% (225)	18.1% (77)	28.9% (123)
BaMS 22	72.5% (308)	11.1% (47)	16.4% (70)

APPENDIX D

Table D.1 Frequencies and Percentages of Responses Given to Each Item of BTMS

Item	Agree	Undecided	Disagree
BTMS 1	71.1% (302)	17.4% (74)	11.5% (49)
BTMS 2	85% (361)	8.5% (36)	6.6% (28)
BTMS 3	16% (68)	16% (68)	68% (289)
BTMS 4	46.6% (198)	22.8% (97)	30.6% (130)
BTMS 5	78.8% (335)	14.8% (63)	6.4% (27)
BTMS 6	18.4% (78)	19.5% (83)	62.2% (264)
BTMS 7	70.4% (299)	19.5% (83)	10.2% (43)
BTMS 8	82.8% (352)	8% (34)	9.2% (39)
BTMS 9	87.8% (373)	8% (34)	4.3% (18)
BTMS 10	79% (339)	12.9% (55)	8% (34)
BTMS 11	21.1% (90)	27.3% (116)	51.5% (219)
BTMS 12	78.9% (332)	13.2% (56)	8.7% (37)
BTMS 13	78.9% (335)	14.4% (61)	6.9% (29)
BTMS 14	82.6% (351)	11.8% (50)	5.7% (24)
BTMS 15	21.9% (93)	11.5% (49)	66.6% (283)
BTMS 16	73.1% (311)	15.1% (64)	8.7% (50)

Table D1 (continued)

Item	Agree	Undecided	Disagree
BTMS 17	82.5% (351)	11.1% (47)	6.4% (27)
BTMS 18	34.5% (147)	27.3% (116)	38.1% (162)
BTMS 19	83.6% (355)	9.9% (42)	6.6% (28)
BTMS 20	50.1% (213)	27.5% (117)	22.3% (95)
BTMS 21	73.7% (313)	12.7% (54)	13.7% (58)
BTMS 22	39.3% (167)	13.2% (56)	46.6% (202)
BTMS 23	76.7% (326)	10.6% (45)	12.7% (54)
BTMS 24	21.4% (91)	35.8% (152)	42.8% (182)
BTMS 25	63.5% (270)	27.3% (116)	9.2% (39)
BTMS 26	84% (357)	9.6% (41)	6.4% (27)
BTMS 27	59.7% (254)	23.3% (99)	17% (72)
BTMS 28	25.4% (108)	13.4% (57)	61.2% (260)
BTMS 29	54.3% (231)	23.1% (98)	22.6% (96)
BTMS 30	30.8% (131)	26.8% (114)	42.3% (180)
BTMS 31	35.8% (152)	16.2% (69)	48% (204)
BTMS 32	58.6% (249)	23.3% (99)	18.1% (77)
BTMS 33	27.3% (116)	36% (153)	36.7% (156)

Table D.1 (continued)

Item	Agree	Undecided	Disagree
BTMS 34	43.8% (186)	21.9% (93)	34.3% (146)
BTMS 35	70.4% (299)	18.1% (77)	11.6% (49)
BTMS 36	35% (149)	24.9% (106)	40% (170)
BTMS 37	73.6% (313)	13.9% (59)	12.4% (53)
BTMS 38	84.5% (359)	8.2% (35)	7.3% (31)
BTMS 39	55.8% (237)	22.6% (96)	21.7% (92)
BTMS 40	87.1% (370)	5.9% (25)	7.1% (30)
BTMS 41	32% (136)	18.6% (79)	49.5% (210)
BTMS 42	60.4% (257)	24.5% (104)	15% (64)

APPENDIX E

Table E1 Alanlara Göre Lise II Haftalık Ders Çizelgesi

DERS KATEGORİLERİ (Haftalık Ders Saati)	FEN BİLİMLERİ ALANI	TÜRKÇE-MATEMATİK ALANI	SOSYAL BİLİMLER ALANI	TEKNİK LİSE BİLGİSAYAR BÖLÜMÜ
ORTAK GENEL KÜLTÜR DERSLERİ	Türk Dili ve Edb.(4) Din Kültürü ve Ahlak Bilgisi (1) Tarih (2) Milli Güvenlik Bilgisi (1)	Türk Dili ve Edb. (4) Din Kültürü ve Ahlak Bilgisi (1) Tarih (2) Milli Güvenlik Bilgisi (1)	Türk Dili ve Edebiyatı (4) Din Kültürü ve Ahlak Bilgisi (1) Tarih (2) Milli Güv. Bil. (1)	Türk Dili ve Edebiyatı (2) Din kültürü ve Ahlak Bilgisi (1) Milli Güvenlik Bilgisi (1)
ALAN DERSLERİ	Biyoloji (2) Fizik (4) Kimya (3) Matematik (5) Geometri (2)	Edebi Metinler (3) Psikoloji (2) Türkiye (Fiziki) Coğrafyası (2) Matematik (5) Geometri (2)	Edebi Metinler (3) Genel Türk Tar.(3) Türkiye (Fiziki) Coğrafyası (3) Ülkeler Coğ. (3) Psikoloji (2)	Matematik (3) Fizik (3) İşletim Sistemleri (3) Uygulamalı Atölye (24)
ALAN SEÇMELİ DERSLERİ	Fizik Uyg. (2) Kimya Uyg. (2) Analitik Geo. (2)	Türk Edb. Tarihi (2) Analitik Geometri (2) Dil Bilim (2)	Sanat Tarihi (2) Türk Edb. Tar. (2) İslam Tarihi (2)	İşletme Bilgisi (2)
SEÇMELİ DERSLER	Beden Eğitimi (2)	Beden Eğitimi (2) Müzik (2)	Beden Eğitimi (2) Müzik (2)	Geometri (2)