BELIEFS OF PRESERVICE MATHEMATICS TEACHERS AT THE MIDDLE EAST TECHNICAL UNIVERSITY AND THE GAZI UNIVERSITY ABOUT THE NATURE OF MATHEMATICS AND THE TEACHING OF MATHEMATICS

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ABSTRACT

BELIEFS OF PRESERVICE MATHEMATICS TEACHERS AT THE MIDDLE EAST TECHNICAL UNIVERSITY AND THE GAZI UNIVERSITY ABOUT THE NATURE OF MATHEMATICS AND THE TEACHING OF MATHEMATICS

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The purpose of this study was to investigate beliefs of preservice 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 the teaching of mathematics.

The research was conducted on 79 fourth year students enrolled at the Mathematics Teacher Education programs at the METU (40) and the Gazi University (39).

Two measuring instruments were utilized: 1. Beliefs about the Nature of Mathematics Scale (BaNoM); 2. Beliefs about the Teaching of Mathematics Scale

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

(BaToM). They were developed by the researcher. The validity and reliability of these scales were tested.

The design of the present study is a cross-sectional survey. The hypotheses of the present study were tested by using t-test or Pearson correlation at the significance level 0.05.

The results of the study indicated that: 1. There is a statistically significant difference between the mean scores of preservice mathematics teachers at METU and those at Gazi University in terms of beliefs about the nature of mathematics and the teaching of mathematics; 2. There is no statistically significant difference between the mean scores of girls and boys in terms of beliefs about the nature of mathematics and the teaching of mathematics; 3. There is a statistically significant relationship between beliefs of preservice mathematics teachers about the nature of mathematics and about the teaching of mathematics.

Key Words: Beliefs, Nature of Mathematics, Teaching of Mathematics, Preservice Mathematics Teachers

ÖZ

ODTÜ VE GAZİ ÜNİVERSİTESİNDEKİ HİZMET ÖNCESİ MATEMATİK ÖĞRETMENLERİNİN MATEMATİĞİN DOĞASI VE ÖĞRETİMİ İLE İLGİLİ İNANÇLARI

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Bu çalışmanın amacı, Orta Doğu Teknik Üniversitesi ve Gazi Üniversitesi'nde okuyan son sınıf matematik eğitimi öğrencilerinin matematiğin doğası ve öğretimi ile ilgili inançlarını araştırmaktır.

Araştırma, Orta Doğu Teknik Üniversitesi (40) ve Gazi Üniversitesi'nde (39) okuyan 79 son sınıf matematik eğitimi öğrencisiyle yürütülmüştür.

Bu araştırma için iki ölçme aracı kullanılmıştır: 1. Matematiğin Doğası İle İlgili İnançlar Ölçeği. 2. Matematiğin Öğretimi İle İlgili İnançlar Ölçeği . Bu araçların geçerlilik ve güvenilirlik çalışmaları yapılmıştır.

Bu çalışma, bir kesitlemesine izleme (cross-sectional survey) araştırmasıdır. Bu çalışmanın hipotezleri 0.05 anlamlılık düzeyinde t-testi ve Pearson korelasyonu kullanılarak test edilmiştir. Çalışmanın sonuçları şunları göstermiştir: 1. Matematiğin doğası ve öğretimi ile ilgili inançları açısından Orta Doğu Teknik Üniversitesi ve Gazi Üniversitesinde okuyan hizmet öncesi matematik öğretmenlerinin ortalamaları arasında istatistiksel olarak anlamlı bir fark bulunmaktadır. 2. Matematiğin doğası ve öğretimi ile ilgili inançları açısından kızlarla erkeklerin ortalamaları arasında istatistiksel olarak anlamlı bir fark yoktur. 3. ODTÜ ve Gazi Üniversitesinde okuyan hizmet öncesi matematik öğretmenlerinin matematiğin doğası ile ilgili inançlarıyla matematiğin öğretimi ile ilgili inançları arasında anlamlı ilişkiler bulunmaktadır.

Anahtar Kelimeler: İnançlar, Matematiğin Doğası, Matematiğin Öğretimi, Hizmet Öncesi Matematik Öğretmenleri

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T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

TABLE OF CONTENTS

ABSTRACT.....III

ÖZ.....V

ACKNOWLEDGEMENTS.....VII

TABLE OF CONTENTS.....VIII

LIST OF TABLES.....XI

LIST OF ABBREVIATIONS.....XIII

CHAPTER

1. INTRODUCTION.....1

2. REVIEW OF LITERATURE.....8

2.1 Theoretical Background.....8

2.1.1.Defining Beliefs.....8

2.1.2.Properties of Belief Systems.....13

2.1.3.Differences Between "Beliefs" and Other Similar Concepts.....17

2.1.3.1.Differences Between "Beliefs" and "Attitudes".....18

2.1.3.2.Differences Between "Beliefs" and "Knowledge".....19

2.1.4.The Importance of Beliefs in Education.....21

2.1.5.The Importance of Beliefs in Mathematics Education.....23

2.1.6.Difficulties and Problems In Studying Beliefs.....28

2.2.Previous Studies.....31

2.2.1.Previous Studies on Preservice Teachers' Beliefs.....31

2.2.2.Previous Studies on Beliefs.....32

3. METHOD OF THE STUDY 50

3.1 Problems of the Present Study and Associated Hypotheses 50

3.2 Research Design 59

3.3 Subjects of the Study 60

3.4 Definition of Terms 60

3.5 Measuring Instruments 61

3.5.1 Beliefs about the Nature of Mathematics Scale (BaNoM): 61

3.5.2 Beliefs about the Teaching of Mathematics Scale (BaToM):.....53

3.6 Procedure 66

3.7 Data Analysis.....66

3.8 Assumptions and Limitations 67

3.8.1 Assumptions 67

3.8.2 Limitations.....68

3.9 Validity of the Present Study.....69

3.9.1 Internal Validity.....69

3.9.2 External Validity.....70

3.9.2.1 Population Validity.....70

3.9.2.2 Ecological Validity 70

4. RESULTS AND DISCUSSIONS.....71

4.1 Results and Discussion of the Hypothesis of the First Sub-Problem 71

4.2 Results and Discussion of the Hypothesis of the Second Sub-Problem..72

4.3 Results and Discussion of the Hypothesis of the Third Sub-Problem.....73

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

4.4 Results and Discussion of the hypothesis of the Fourth Sub-Problem 75

4.5 Results and Discussion of the Hypotheses of the Fifth Sub-Problem 76

5. CONCLUSIONS AND RECOMMENDATIONS 102

5.1.Conclusions.....102

5.2 Recommendations.....104

REFERENCES 106

APPENDICES

APPENDIX A.....112

APPENDIX B 112

APPENDIX C.....112

APPENDIX D.....112

LIST OF TABLES

TABLE

4.1 Comparison of Mean Scores of Preservice Mathematics Teachers at the METU and those at the Gazi in terms of BaNoM 72

4.2 Comparison of Mean Scores of Preservice mathematics teachers at the METU and the Gazi University in terms of BaToM 74

4.3 Comparison of Mean Scores of Girls and Boys in terms of BaNoM.....75

4.4 Comparison of Mean Scores of Girls and Boys in terms of BaToM.....76

4.5 Frequencies and Percentages for BaNoM 1 and BaToM 2.....79

4.6 Frequencies and Percentages for BaNoM 2 and BaToM 6.....81

4.7 Frequencies and Percentages for BaNoM 3 and BaToM 1.....82

4.8 Frequencies and Percentages for BaNoM 4 and BaToM 1.....83

4.9 Frequencies and Percentages for BaNoM 4 and BaToM 28.....84

4.10 Frequencies and Percentages for BaNoM 5, BaToM 8.....85

4.11 Frequencies and Percentages for BaNoM 5, BaToM 13.....86

4.12 Frequencies and Percentages for BaNoM 6 and BaToM 6.....87

4.13 Frequencies and Percentages for BaNoM 6 and BaToM 25.....87

4.14 Frequencies and Percentages for BaNoM 6 and BaToM 26.....88

4.15 Frequencies and Percentages for BaNoM 7 and BaToM 10.....90

4.16 Results of Pearson Correlation between BaNoM 8 and BaToM 8, 10, 13 and 17.....91

4.17 Frequencies and Percentages for BaNoM 9 and BaToM 11.....93

4.18 Frequencies and Percentages for BaNoM 10 and BaToM 8.....94

4.19 Frequencies and Percentages for BaNoM 10 and BaToM 13.....95

4.20 Frequencies and Percentages for BaNoM 10, and BaToM 30.....96

4.21 Frequencies and Percentages for BaNoM 11 and BaToM 11.....97

4.22 Frequencies and Percentages for BaNoM 13, and BaToM 26.....99

4.23 Frequencies and Percentages for BaNoM 14, and BaToM 11.....100

4.24 Frequencies and Percentages for BaNoM 16, and BaToM 6.....101

C.1 Frequencies and Percentages of Responses Given to Each Item of BaNoM..118

D.1 Frequencies and Percentages of Responses Given to Each Item of BaToM...119

LIST OF ABBREVIATIONS

BaNoM: Beliefs About the Nature of Mathematics Scale

BaToM: Beliefs About the Teaching of Mathematics Scale

METU: Middle East Technical University

CHAPTER 1

INTRODUCTION

In the past four decades, attention in research on teaching has turned from the content of teaching and learning to the context in which they occur (Manouchehri, 1997). Pajares (1992) stated that although research on teacher thinking was abundant and thriving, critics had questioned how its findings can be of use to teachers or teacher education and they suggested that another perspective is required for understanding teacher behaviors, a perspective which focuses on the things and the ways that teachers believe.

The urgent need and pressure for serious reforms in teacher education programs came out as the key factors for the shift in researchers' attention. Thompson (1984) showed that teachers' beliefs, views and preferences about mathematics and its teaching, play a very important role in shaping the teachers' characteristic patterns of instructional behavior. Efforts for educating and preparing better teachers led the researchers in a new path. Lasley (1980) proposed that understanding beliefs about the nature of teachers, about the teacher education and about the classroom, and detailing reasons for these beliefs were necessities in the world of preservice teacher education. Brousseau and Freeman (1988) stated that when attention focuses on efforts to improve the ways candidates will ultimately act in their classrooms, curriculum planners in teacher education must also consider

educational dispositions and beliefs. Frank (1990) suggested that teacher educators should also be concerned with what future teachers believe about they are being trained to teach as much as they are concerned with these teacher candidates' content knowledge. According to Ernest (1989), official pressure for reform in the teaching of mathematics overlooked the psychological foundations of the practice of teaching mathematics, including the teacher's knowledge, beliefs and attitudes, which were key factors. He also states that this area was also under-emphasized by research on teaching and teacher education programs. As the years passed, approaches to this "overlooked" or "under-estimated" area changed and it became a major area of research. Pajares (1992) mentioned that many researchers had agreed that beliefs teachers hold influence their perceptions and judgments, which, in turn, affect their behaviors in the classroom and understanding the belief structures of teachers and teacher candidates is essential to improving their professional preparation and teaching practices. Manouchehri (1997) stated that a similar shift occurred in the view of the school curriculum, which was then less a collection of topics than a set of experiences, and counted teacher beliefs among four reform areas in educating mathematics teachers, examined by recent researchers on mathematics teacher education. The other three were content knowledge, pedagogical content knowledge and pedagogical reasoning.

An alternative account of the meaning and nature of mathematics emerged from a sociological analysis of mathematical knowledge based on the ongoing practice of mathematicians (Thompson, 1992). In this alternative account,

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

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 social and cultural setting (Thompson, 1992). Certainly, also these suggestions or alternative approaches to the meaning and nature of mathematics sprung from a relatively new view. According to Pajares (1992), this view is based on the assumption that beliefs are the best indicators of the decisions individuals make throughout their lives, an assumption that can be traced to human beings' earliest philosophical contemplations.

Despite the absence of a consensus on a concrete definition of beliefs, there exist several definitions. In the present study the concept of "beliefs" is used in the sense Ernest (1989) defined. According to him "beliefs" are conceptions, values, ideology, and dispositions.

Certainly, researchers have had reasons for not focusing on "beliefs". For many years, behaviors, which are thought to be more 'observable' or more suitable for empirical research projects, are widely and deeply examined. These efforts certainly led many improvements in the field but especially after late 1970's, researchers started focusing on the question, "why teachers behave like that?" rather than "how teachers behave". What teachers think became an important field of study. According to Bolin (1988), teacher thinking has become something of a catch phrase in the 1980s. There were many questions expecting answers: "Why teachers behave in the way they behave?" "What determines or causes behavior?" "How do teachers

define reality?" "How do they give meanings to their profession and to their lives?" "What are the differences among concepts like 'beliefs', 'attitudes' and 'knowledge'?" etc.

Of course the problems in studying teacher beliefs did not disappear suddenly. Some researchers tried to diagnose the matter and find some solutions to these problems (Pajares, 1992; Ernest, 1989). Pajares (1992) defined the causes of difficulties in studying teacher beliefs as definitional problems, poor conceptualizations, and differing understandings of beliefs and belief structures. Ernest (1989) used the name "missing program" for the psychological foundations of the practice of teaching mathematics, which include the teacher's knowledge, beliefs and attitudes and tried to contribute to this "missing program" by his studies. These researchers' reason for calling this area as "missing program" is the lack of studies on the field. Ernest (1989) offered a model of the cognitive structures; the knowledge, beliefs and attitudes specific to the teacher of mathematics.

There are numerous studies on beliefs of students and teachers (Pajares, 1992; Ernest, 1989; Bolin ,1988; Thompson 1984; Brickhouse, 1990, Schoenfeld 1989). These studies vary in terms of methodology and subjects of the study. Most of the studies in the field are qualitative ones. In other words, generally qualitative methods are preferred methods in the study of beliefs. Other than these kinds of studies, there are very important studies focusing on meanings, concepts, constructs and definitions. One of the aims of researchers working on these kinds of projects are, as Pajares (1992) wrote, "cleaning up messy constructs" and constructing a frame of

reference for the field. Even after a little review of literature, it would be very easy to notice that commonly used constructs, words mean different things to different people. Another important researcher dealing with this subject, Ernest (1989) proposed an analytic model of the different types of knowledge, beliefs, attitudes of mathematics teachers, and their relationships with practice. These efforts should be considered as crucial since without a consensus on definitions of the subjects that are studied, it would be extremely difficult for researchers to justify their findings on scientific platforms.

An awareness of the significant roles that beliefs play in cognitive behavior and ensuing interest in belief systems as a topic of study have developed concurrently and yet independently, among mathematics education researchers interested in teachers' cognitions and those interested in students' cognition and for both groups, the study of beliefs has emerged in recent years as an important, legitimate line of research (Thompson, 1992). In addition, Bunting (1984) states that knowledge of the content of beliefs is an important first step in the identification of variables within the educational context, which mediate between the thinking and practice of teachers. More particularly, Ball (1988) considers the knowledge about what teacher education students bring and what they learn from different components of and approaches to professional preparation (their beliefs) as a critical piece to the puzzle of improving the impact of mathematics teacher education on what goes on in mathematics classrooms. This essential knowledge can be acquired via research studies like the present study.

Thompson (1984) showed that teachers' consciously or unconsciously held beliefs, views and preferences about mathematics and its teaching play a significant role in shaping the teachers' characteristic patterns of instructional behavior. Everybody's beliefs are somehow connected to each other and constitute a "system". Strangely, beliefs constituting this system are not always consistent in each other. By investigating the relationship between beliefs about the nature of mathematics and beliefs about the teaching of mathematics it is aimed to understand how consistent the belief systems of preservice teachers was.

In Turkey the number of studies in the area of teacher beliefs is too few (e.g. Aksu, Demir & Sümer, 1998). Research on beliefs itself can be said to be a very new area in Turkey. In this specific case, "mathematical beliefs of preservice mathematics teachers" stands as an almost untouched concept. As explained above, in other countries of the world there is both public and official pressure on teachers and teacher educators for an educational reform, which establishes a starting point for researchers. Unfortunately in Turkey, such a demand rises neither from the society nor from the government. If the need for radical reforms in the education system of Turkey recognized, it would be explicitly seen that the research on beliefs of teacher education faculty members, teachers and students about education, their subject matters, education system, and faculties of education would be one of the most reliable diagnostic tools.

What teachers believe about mathematics and the teaching of mathematics influence what they do in the classrooms and what the teacher does in the classroom influences students' beliefs about mathematics (Carter & Norwood, 1989).

Consequently, in the present study we have two aims. The first one is to investigate beliefs of preservice mathematics teachers about nature of mathematics and teaching of mathematics.

With this study it is aimed to make a contribution to research efforts in the field in two ways. First it is a research study. It has a descriptive side. It is supposed to help researchers have an idea on beliefs of prospective mathematics teachers who were just about to be graduated from the Middle East Technical University and the Gazi University. What could be considered as beliefs of these prospective mathematics teachers, which ones of their beliefs were shared in both of these two universities and which ones were not is presented in the present study. In addition to all these, correlations between the beliefs about the nature of mathematics and the beliefs about the teaching of mathematics were also investigated. This investigation may give an idea on internal consistency of the belief systems of the subjects.

The second aim of the present study is to provide a framework for the study on beliefs, which is a very new research area in Turkey. A large compilation of discussions and efforts for reaching a consensus on definitions, meanings, and concepts will take place in the "theoretical background of the study" section.

CHAPTER 2

REVIEW OF LITERATURE

In this chapter, first, the theoretical background of the subject is given. Secondly, the previous research studies conducted on beliefs are given.

2.1. Theoretical Background

This chapter covers the theoretical background of the subject. Definitions of the concept of "belief", information about the belief systems, differences between beliefs and other similar concepts like "attitudes" and "knowledge", importance of beliefs and difficulties in studying beliefs are all explained in this chapter.

2.1.1. Defining Beliefs

Although "teacher's beliefs" is a popular research topic, the concept of belief has not been dealt with in substantial way in the educational research literature and generally, researchers have assumed that readers know what beliefs are (Thompson, 1992). In fact the concept of beliefs needs to be defined properly before any further research. According to Pajares (1992) the construct of beliefs is a messy construct that needs to be cleaned up. Here a question arises: Why do not we have yet a clear

definition of beliefs? Thompson (1992) provides two different reasons for this situation. First one of these reasons is the difficulty of distinguishing beliefs and knowledge springing from the close connection that exists between beliefs and knowledge. Second explanation for the lack of discussions in educational research literature on the nature of beliefs and for the lack of clear definitions is, that the value of searching for definitive characterizations of the two concepts of beliefs and knowledge is arguable for educational research. These two concepts and the words associated with them are so broad that to search for definitive characterizations of either may prove to be futile (Thompson, 1992).

Thompson (1992) advised researchers interested in studying teacher's beliefs to give careful consideration to the concept, both from a philosophical as well as psychological perspective, since philosophical works can be helpful in clarifying the nature of beliefs and psychological studies may be expected to prove useful in interpreting the nature of the relationship between beliefs and behavior as well as in understanding the function and structure of beliefs. Even in the light of this advice, finding a clear-cut definition of beliefs is difficult. Pajares (1992, p.309) explains this as follows:

> *"Educational psychology does not always accord its constructs very precisely, and so defining beliefs is at best a game of player's choice. They travel in disguise and often under alias – attitudes, values, judgments, axioms, opinions, ideology, perceptions, conceptions, conceptual systems, preconceptions,*

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

dispositions, implicit theories, explicit theories, personal theories, internal mental processes, action strategies, rules of practice, practical principles, perspectives, repertories of understanding, and social strategy, to name but a few that can be found in the literature."

Ernest (1989) using some of the concepts given above defines "beliefs" as, the teacher's conceptions, values, ideology, and dispositions.

Examining the cognitive foundations of beliefs may provide a path for reaching a definition. Bem (1970) states that beliefs, attitudes, and values do seem to be logically connected, and this mixture of logic and psycho-logic constitutes the cognitive foundations of beliefs and attitudes. He examines the concept of beliefs in two categories: Primitive beliefs and higher-order beliefs. He also provides some sub-categories for primitive beliefs. Before giving details of these categories and sub-categories he define beliefs as follows:

"If a man perceives some relationship between two things and between some thing and a characteristic of it, he is said to hold a belief."

After giving a definition, he articulates that many beliefs are the product of direct experience and every belief can be pushed back until it is seen to rest

ultimately upon a basic belief in the credibility of some external authority. He proposes that other beliefs may derive from these basic beliefs but the basic beliefs themselves are accepted as givens, and names these basic beliefs as "primitive beliefs". Among these some are so taken for granted that people are apt not to notice that they hold them at all, they remain unaware of them until they are called to their attention or are brought into question by some bizarre circumstance in which they appear to be violated. Man's faith in the validity of his sensory experience is the most important belief.

Bem (1970) names the primitive beliefs, which are "non-conscious" axioms upon which other beliefs are built, as "zero-order beliefs". He names the primitive beliefs that are consciously held and require no justification beyond a brief citation of direct experiences as "first-order beliefs". First order beliefs are based upon a zero order belief in the credibility of an external authority or based upon an axiomatic belief in the credibility of human senses. For example a child may believe that inside of every watermelon is red. This is an example of a first order primary belief based upon an axiomatic belief in the credibility of human senses. He believes so because he has seen that it is red before (previous experience and credibility of senses). On the other hand a child may believe that if he does not brush his teeth after every meal, this will cause tooth decay. He believes like that since his mother has said that, and mothers are credible authorities for children. the source for the belief in this second example is not direct experience. According to Bem (1970), stereotypes are over generalized first-order beliefs based on a too limited set of experiences. The

second category of beliefs, "higher-order beliefs", builds on a "vertical structure" of beliefs underneath them, beliefs, which "generate" them as the product of quasi-logical inferences. In these kind of beliefs, an explicit and conscious premise exists. For example, reasoning inductively from experiences may help a mathematics teacher derive a higher order belief as follows:

Experience: *"My students who solve more examples than others are more successful in my examinations."*

Premise: "*The examinations that I design (the questions that I prepare) truly measures mathematics ability".*

Conclusion (belief): *"In order to develop mathematics ability, students should solve as many examples as they can."*

Another mathematics teacher can believe that in order to develop mathematics ability, students should work on a few difficult problems using problem-solving methods, not many easy examples that can be solved using definite procedures. Such a belief would also be called a higher-order belief since it would have its own vertical structure, own premises, own reasoning.

Higher order beliefs might be expected to be quite vulnerable to disconfirmation because any one of the underlying premises could be destroyed, and because of this, a higher-order belief would appear to be as strong as its weakest link. This is not true since most of higher-order beliefs are also bolstered by "horizontal" structures. That is, a particular higher-order belief is often the conclusion to more than one chain of reasoning.

2.1.2. Properties of Belief Systems

All the different beliefs one hold constitutes a belief system. Beliefs, which constitute a belief system, are connected to each other. In other words, belief systems generally have an internal consistency. These belief systems influence almost every decision one makes. In this sense, Munby (1982) states that all human perception is influenced by the perceiver's schema, constructs, existing beliefs and understandings but, these "knowledge structures" themselves are not infallible guides to the nature of physical and social reality. He adds that beliefs influence the way in which events are characterized. Even the testing of one's beliefs against experience is influenced by beliefs themselves for they interact with how one perceives data. So earlier theories and beliefs about social and physical reality are less likely to change-first or early evidence tends to give rise to less tractable conceptions and views. Neither is this the sole difficulty in altering beliefs for they bias one's interpretation and recall of evidence, leading one to recognize more readily confirming evidence.

How do these belief systems that influence human beings in such a scale develop? What is the source of the beliefs? On the evolution of beliefs and their properties Lasley (1980) states that beliefs evolve as individuals are exposed to the ideas and mores of their parents, peers, teachers, neighbors, and various significant others and they are acquired and fostered through literature, media, popular folklore, schooling, the informal observation of others, and through the folklore of a culture, and they usually persist, unmodified, unless intentionally or explicitly challenged.

On the teachers' sources of beliefs in Thompson (1984) noted that teachers develop patterns of behavior that are characteristic of their instructional practice. In some cases, these patterns may be manifestations of consciously held notions, beliefs, and preferences that act as 'driving forces' in shaping the teacher's behavior. In other cases, the driving forces may be unconsciously held beliefs or intuitions that may have evolved out of the teacher's experience.

Frank (1988) noted that mathematical beliefs do not develop overnight. They develop slowly, over a long period of mathematical encounters and experiences. Most students' primary source of mathematical experiences is probably the mathematics classroom. Thus, what goes on in the classroom will strongly influence the mathematical beliefs of the students in that classroom. Students learn much more than mathematics content from classroom experiences. They are also developing mathematical beliefs that can help -or hinder- them as problem solvers. Some researchers emphasized the point that schools are the most important places where beliefs develop first. Monouchehri (1997) noted that researchers have explored prospective teachers' receptivity to teacher education and found that teachers acquire their beliefs, for the most part, during their schooling years; their experiences as students of mathematics further shape their beliefs. Raymond and Santos (1995) wrote that, current teachers, when students, often-experienced mathematics classes consisting of a predictable pattern of lectures followed by seatwork. Their quizzes and tests required of what their teachers had spelled oft in class. Not surprisingly, they base their mathematical beliefs on these experiences. They named this as "the

chain of beliefs about mathematics" and added that individuals internalize such beliefs through continuous exposure to school and home situations that reinforce the notion that this is the true nature of mathematics. Manouchehri is (1997) research findings provided evidence that teachers' views of teaching and learning as well as the nature of the subject matter are shaped by their own experiences as learners.

Starting from this point, Austin (1992) provided evidence that math-anxious elementary teachers may affect their pupils adversely. A child's attitude toward mathematics is a learned attitude that develops through math experiences, many of which take place in the elementary classroom where some teachers transmit their undesirable attitudes toward mathematics to their students.

Mcdiarmid (1990) approached to beliefs of prospective teacher from a different side, and proposed that, prospective teachers' tacit assumptions about the teacher's role, pedagogy, learning, diverse learners, subject matter, context, and learning to teach constitute a web of beliefs. As one strand of a web supports and is supported by those strands in contact with it, so too prospective teachers' beliefs support one another.

For the teachers' conceptions and behaviors, Thomson (1984, p. 122) defined two general characteristic qualities of the teachers: 'Integratedness' and 'Reflectiveness'. He defines these characteristic qualities as follows:

> *"**Integratedness:** A criterion for inferring the integratedness of someone's beliefs and views in a given domain- to extent to which these form a coherent conceptual system, as*

opposed to each belief existing in isolation from the others-is the extent to which they interrelate and interact to modify each other. By this measure, if someone holds incongruous or contradictory beliefs, then it is legitimate to infer that those beliefs exist in isolation with respect to each other; inversely, if it appears that someone modifies his or her beliefs so as to resolve or avoid inconsistencies, either in thought or deed, then it is legitimate to infer that he or she is holding these beliefs in relation to one another, and has integrated them into a more or less coherent system.

Reflectiveness: *Beside differences in the integratedness of the teachers' conceptions of mathematics, they differed in their awareness of the relationships between their beliefs and their practice, the effect of their actions on the students, and the difficulties and subtleties of the subject matter. These differences seemed to be related directly to differences in the teachers' reflectiveness-in their tendency to think about their actions in relation to their beliefs, their students, and the subject matter."*

There are many different categorizations of preservice teacher beliefs in the literature. For example, Raymond and Santos's (1995) analysis of their preservice teacher data resulted in three thematic categories: beliefs about self as a doer of

mathematics; beliefs about knowing, learning, and teaching mathematics; and the disequilibration process provoked by a course which was specially designed for this research. By disequilibration, the difference caused by the course challenging the beliefs of the subjects is meant. Beliefs about self as a doer of mathematics included three issues: students' perceptions of mathematics and their view of its importance or usefulness, their feelings towards mathematics (this is liking or disliking which in fact should be categorized below the heading of "attitudes"), and their assessment of their ability to do mathematics.

Yet other researchers drawing attention to importance of existing beliefs and experiences on teachers' construction of understanding of mathematics are Carter and Norwood (1997). Just like Mcdiarmid, they emphasized the difficulty in changing teachers' beliefs:

> *"From past reform movements it is evident that teachers are not going to change their beliefs simply because it has been recommended. A powerful reason for change must be present for change to occur. Therefore the recognition for the need to change is a mandatory first step." (Carter & Norwood, 1997, p. 62)*

2.1.3. Differences Between "Beliefs" and Other Similar Concepts

Previously it was stated that "belief" is a "messy construct". Insufficient definitions lead misunderstandings and because of this, differences among the concepts "beliefs", "attitudes", and "knowledge" are delineated below.

2.1.3.1. Differences Between "Beliefs" and "Attitudes"

In many research papers, the concept "attitudes" is mistakenly used instead of "beliefs". There is a clear distinction between "beliefs" and "attitudes". Bem (1970) defines attitudes as:

> *"Attitudes are likes and dislikes. They are our affinities for and our aversions to situations, objects, persons, groups, or any other identifiable aspects of our environment, including abstract ideas and social policies."*

Ernest (1989) proposes two attitude components for the teaching of mathematics. According to him the first category, teacher's attitudes to mathematics include liking, enjoyment and interest in mathematics, or their opposites, which in the extreme case can include mathephobia. The second category, the teacher's attitudes to the teaching of mathematics, include liking, enjoyment and enthusiasm for the teaching of mathematics, and confidence in the teacher's own mathematics teaching ability (or their opposites).

As seen in the definitions above, attitudes are somehow related to emotions, feelings. Beliefs, on the other hand, have cognitive roots. Beliefs are more questionable than attitudes. If an individual simply likes the red color, he or she does not need to have a reason for that. No one can be asked why he/she likes red color. But if he or she believes that red is the most appropriate color for women, this belief has questionable roots. Why he/she thinks so, is open to questions.

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

2.1.3.2. Differences Between "Beliefs" and "Knowledge"

Thompson (1992) considers the difficulty of distinguishing between beliefs and knowledge as an explanation for the scarcity of reasoned discourses on beliefs in the educational literature. He adds that because of the close connection that exists between beliefs and knowledge, distinctions between them are fuzzy. Therefore some educators have argued that it is not useful for researchers to search for distinctions between knowledge and belief, but, rather, to search for better and how, if at all, teachers' beliefs – or what they may take to be knowledge- affect their experience. Pajares (1992) states that distinguishing knowledge from belief is a daunting undertaking. Ernest (1989) explains the difference between belief and knowledge by means of an example. He states that it is possible for two teachers to have very similar knowledge, but for one to teach mathematics with a problem-solving orientation, whilst the other has a more didactic approach. This difference springs from the difference between their beliefs. Nespor (1987) suggests that beliefs have stronger affective and evaluative components than knowledge and that affect typically operates independently of the cognition associated with knowledge. He also argues that belief systems, unlike knowledge systems, do not require general or group consensus regarding the validity and appropriateness of their beliefs and individual beliefs do not even require internal consistency within the belief system. This nonconsensuality implies that belief systems are by their very nature disputable, more inflexible, and less dynamic than knowledge systems. Pajares (1992) notes some other approaches to the matter of distinguishing between beliefs and

knowledge: Knowledge may be conceptualized as a structure composed of a cognitive component, schematically organized, and a belief component, possessing elements of evaluation and judgment. He explains this by using the following example:

> *"A teacher's knowledge of what typically happens in a school or his understanding of the faculty handbook are instances of cognitive knowledge. "Knowing" that Jim is a troublemaker or that boys are better at mathematics than girls are examples of a second kind of knowledge, belief. (Pahares, 1992, p. 310)"*

As seen, educators having this approach view belief as knowledge of a sort.

Thompson (1992) also provides some distinction points. His first distinction point is that beliefs can be held with varying degrees of convictions. Second distinctive feature of beliefs is that they are not consensual. Believers are aware of the fact that others may think differently. A claim to knowledge must satisfy a truth condition, whereas beliefs are independent of their validity. As a third point, he takes 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.

2.1.4 The Importance of Beliefs in Education

Stressing the importance of beliefs in education, Lasley (1980) asked whether teacher educators were doing everything that they can to encourage prospective teachers to critically examine their beliefs about teaching or not. He proposed that stating beliefs about the nature of teachers, teacher education and the classroom and detailing reasons for these beliefs were necessities in the world of preservice teacher education. This was one of the ways of preservice teachers. This challenging the beliefs is required since unchallenged beliefs may even hinder learning about more appropriate responses to the reality that does exist.

According to Manouchehri (1997) research consistently shows teachers translate their knowledge of mathematics and pedagogy into practice through the filter of their beliefs. Few would argue the importance of studying on this filter.

In fact beliefs are the most important keys in setting goals or defining aims in a classroom, a school, a city or in a whole country. Munby (1982) emphasized that inconsistencies in goal setting may spring from inconsistencies in teachers' beliefs about the nature of children, beliefs about themselves and their roles as teachers, and beliefs about the aims of education and how to achieve them. In such times teachers may ignore the information, discount it or distort it to make it shaped according to

them. Here it comes out that even very well defined or organized curricula would not be enough to reach desired goals in education. Munby (1982) considered teachers' beliefs and repertories of understandings as very important parts of teacher thinking which should be studied and understood before much more work on teacher thinking is pursued. He stated that the importance of research on teacher thinking (and teacher beliefs in this sense), planning and decision making was frequently averred and remained uncontested in recent literature. This field required more study because it was expected to give insight into classroom events, and worth understanding because of its connection to student learning. He also found it surprising that relatively little attention has been paid to beliefs in research on teacher thinking (and beliefs in particular) as compared to their obvious importance. He also reviewed selected studies on teacher thinking to show how inadequate attention to beliefs (either the teachers' or the researchers') can seriously weaken the inferences drawn.

Considering the importance and the role of information on beliefs, Brousseau and Freeman (1988) noted the existence of a wrong approach in contemplating reforms in teacher education curricula: Educators are most likely to think in terms of changes that will upgrade teacher candidates' professional knowledge or teaching skills. But these views are short sighted. When attention is given on efforts to improve the ways candidates will ultimately act in their classrooms, it is evident that curriculum planners in teacher education must also consider educational dispositions and beliefs. They also added two important statements from different researchers. Fenstermacher (1979) argued that, "If on purpose and intent are to change the

practices of those to teach, it is necessary to come to grips with the subjectively reasonable beliefs of teachers." Feiman-Nemser and Floder (1986) proposed that, "Teacher education must build on or rebuild what teachers and teachers-to-be already believe about their work."

McDiarmid (1997) articulated his thoughts on the importance of beliefs in making decisions about means and goals by following worlds:

"Unless I know what my students are thinking, what ideas, experiences, and beliefs they bring with them, as well as what they understand about the ideas and experiences they encounter in the courses (given at the university), (as a teacher educator) I will make decisions about means and goals blindly."

Brousseau, Book and Byers (1988) stated that the knowledge of what teachers and teachers-to-be already believe about their work, their beliefs about teaching during various stages of preparation, can provide insight for teacher education programs and instructional leaders. A first step toward understanding how to affect the process of schooling would be to understand and the values and beliefs of those who drive those processes.

2.1.5 The Importance of Beliefs in Mathematics Education

In every level of education system, many goals are defined for improving the quality of math education. Self-confidence in mathematics, being good problem solvers and a good understanding of mathematical concepts can be counted among

the desired goals for students. Research on students' beliefs about mathematics reveals a set of mathematical beliefs, -which are labeled as "math beliefs" that can be counterproductive to achieving these goals (Frank, 1990). She stated that teacher educators should also be concerned with what future teachers believe about they are being trained to teach as much as they are concerned with these teacher candidates' content knowledge. Frank (1988) explicitly stated that students may not be able to become better problem solvers unless they change their beliefs about mathematics.

Aksu, Demir and Sümer (1998) explain the place (and importance) of beliefs in education by a logical reasoning series. According to them the beliefs of students' beliefs about learning and the structure of the subject affects their learning. What a teacher does in the classroom affects the beliefs of students about mathematics. At the same time what teachers' beliefs about the nature of mathematics and the teaching of mathematics affects their teaching and so teachers' beliefs affects students' beliefs.

What is the relationship between beliefs and mathematical performance? In other words, do beliefs have an important effect on achievement in mathematics? After stating that success or failure in solving mathematical problems often depends on much more that the knowledge of requisite mathematical content, Garofalo (1989) stated that other factors, such as the decisions one makes, strategies one uses, the emotions one feels and the beliefs are holds relevant to performance on mathematical tests, influence the direction and outcome of one's performance. He added that although not explicitly addressed in typical mathematics instruction, these factors are

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

nonetheless important aspects of mathematical behavior, not only because they influence how one thinks about, approaches, and follows through on mathematical tasks but also because they influence how one studies mathematics and how and when one attends to mathematics instruction.

Thompson (1984) proposed that there was strong reason to believe that in mathematics, teachers' conceptions (their beliefs, views, and preferences) about the subject matter and its teaching play an important role in affecting their effectiveness as the primary mediators between the subject and learners. The findings of Thompson (1984) showed that teachers' beliefs, views and preferences about mathematics and its teaching, regardless of whether they are consciously or unconsciously held, play a significant, albeit subtle, role in shaping the teachers' characteristic patterns of instructional behavior. In particular the observed consistency between the teachers' professed conceptions of mathematics and the manner in which they typically presented the content in this study, strongly suggests that the teachers' views, beliefs, and preferences about mathematics do influence their instructional practice (Thompson 1984). He warned that if teachers' characteristic patterns of behavior are indeed a function of their beliefs, views and preferences about the subject matter and its teaching (something that is proven by this study), then any attempt to improve the quality of mathematics teaching must begin with an understanding of the beliefs of teachers and their relation with teachers' instructional practice. Therefore, failure to recognize the role that the

teachers' beliefs might play in shaping their behavior is likely to result in misguided efforts to improve the quality of mathematics instruction in schools.

Raymond and Santos (1995) noted the importance of understanding implicit theories and beliefs of in-service and preservice teachers, by referencing many researchers who suggested that teacher beliefs about what mathematics was and what it meant to know, do, and teach mathematics may be driving forces in instruction of mathematical ideas. Another evidence for supporting the importance of beliefs in Raymond and Santos' (1995) study is the suggestion of National Research Council to schools to consider the role of teachers' beliefs in students' motivation, performance, and achievement in mathematics.

Manouchehri (1997) stated that the ways that teachers teach and the ways teachers evaluate the content are determined by what they believe about the nature of mathematics, mathematics learning, and mathematics teaching. Referencing Thompson (1984), Manouchehri (1997) adds that what teachers consider as desirable goals for the mathematics program, their own role in teaching, legitimate mathematical purposes, and acceptable outcomes of instruction are part of their conception of mathematics teaching.

Case studies by Thompson (1984) showed evidence of differences among the teachers in the specific beliefs, views, and preferences that they held regarding mathematics and its teaching. He stated that although the complexity of the relationship between conceptions and practice defies the simplicity of cause and effect, much of the contrast in the teachers' instructional emphases might be

explained by differences in their prevailing views of mathematics. Another finding in this study was that the teachers' views about planning and preparing for instruction were found to be related to their conception of mathematics.

Erickson (1993) noted that teachers' perceptions or beliefs are becoming recognized as powerful determinants of teacher behavior. Particularly, teachers' beliefs about mathematics as an organized body of knowledge, as a way to describe the world, or as a creative art help teachers decide not only what to teach but also how to teach. Mathematics teacher's views about the nature of mathematics and their perceptions about the purpose of education are possible important factors in their curricular decisions and their instructional planning. Highly skilled and motivated teachers and teacher educators who communicate the nature of mathematics and the purpose for studying the subject are key to improving mathematics programs.

Brickhouse (1990) proposed that teachers' beliefs about science-including beliefs about mathematics- influenced not only explicit lessons about the nature of science, but also shaped an implicit curriculum concerning the nature of scientific knowledge. Teachers start to use different methods and sometimes follow an alternative curriculum with respect to their beliefs. Brickhouse (1990) also stated as a warning that, teacher education will make little impact on practice, if beginning teachers are unable to implement instruction consistent with their beliefs about science.

Carter and Norwood (1997) stated that the recognition of the importance of the teacher beliefs about mathematics has been the topic of many recent articles in

teacher education. They also stated that while it is evident that teacher beliefs influence what occurs in the classroom, the scope and the magnitude of the effect of these beliefs has not been clearly delineated. The study on belief needs more attention. They stated that beliefs and many aspects of beliefs are already of particular interest in the United States as the National Council of Teachers of Mathematics (NCTM) in the Curriculum and Evaluation Standards published in 1989 encourages widespread mathematics reform. Carter & Norwood (1989, p. 62) concluded:

> *"It is evident that what the teacher does in the classroom influences students' beliefs about mathematics. It is also evident that what teachers believe about mathematics and the teaching of mathematics influence what they do in the classroom and that their beliefs may be translated into students' beliefs."*

2.1.6 Difficulties and Problems In Studying Beliefs

Although the importance of beliefs in drawing inferences about teacher thinking was recognized and teachers' beliefs were explicitly dealt, an important problem continued existing: Teachers as subjects of the studies and researchers were assumed to share the same perceptions. This was a thematic problem. Teachers' and researchers' beliefs and understandings thought to be such that they attach equal significance to and derive identical meaning from such things as "cues about

students" which teachers were sometimes given in studies, and from statements offered in stimulated recall techniques (Munby, 1982).

How should researchers determine what in-service or preservice teachers believe? Directly asking them what they believe seems as an immediate basic answer to this question. But Munby (1982) provides several reasons for showing this alluringly simple approach is not suitable:

> *"First, the fact that the question is worth asking implies a commitment to the view that people have different beliefs and, thus, perspectives. To honor this is to comprehend the awkwardness of asking a question, which gives no hint of the perspective from which it might be answered. To be sure, the perspective ought to be that of the teacher, but it is difficult to grab this perspective before asking a question about what it is. Next, while subscribing to the view that our beliefs construct our experience, it is necessary to recognize that individually we may not be the best people to clearly enunciate our beliefs and perspectives since some of these may lurk beyond ready articulation." (Munby, 1982, p. 217)*

Discussing the reliability of the test measuring beliefs of prospective teachers', McDiarmid (1990) proposes that the only reliable test of changes in belief is what prospective teachers do in their classrooms.

According to Carter & Norwood (1997), measuring the beliefs and changes in beliefs of both the students and their teachers can only provide a snapshot of what is going on within a classroom without requiring significant resources. These snapshots can be used to evaluate the effectiveness of professional development workshops. They can also be used to make teachers aware of their beliefs and the relationship of their beliefs to their students' beliefs and provide the springboard for teachers to reflect on their classroom practices. It can also serve as a way to evaluate student progress in reform efforts.

Brousseau, Book and Byers' (1988) stated that given the current state of the art, no single study that tries to define components of a teaching culture can meaningfully inform local school policy (not to mention national or international reform issues). In fact it is not possible to assume that all teachers share the same teaching culture. They differ in experience, gender, age, experience, socio-economic background, wisdom and ability. One of the main problems that researchers face is how to design studies and inferences in the light of this diversity.

Especially drawing inferences from quantitative data resembles to making interpretations about soap opera series, their subjects, their characteristics, actors, actresses, and the quality of technical material used, only by seeing one snapshot picture from just one of them, even without watching them. Beliefs are dynamic factors. They are challenged in time and modified continuously. They are also very personal. No two individual can be guaranteed to hold same beliefs. Every component of education has its own effects on beliefs. To be able to reach correct

interpretations at least the effect of several components like social and cultural background, gender, subject matter, economic state of the school should be taken into consideration, studies should be realized in longer periods of time and should include qualitative methods. This is required for not having a snapshot picture but watching at least several episodes of the series. Beside these it should still be kept in mint that any instrument that attempts to describe aspects of the teacher's complex world has limitations (Brousseau, Book & Byers, 1988)

2.2. Previous Studies

In this section, previous research studies on beliefs in general, and research studies on beliefs of preservice teachers are summarized. Both qualitative and quantitative research studies conducted previously are covered.

2.2.1. Previous Studies on Preservice Teachers' Beliefs

Although the field of mathematical beliefs considered as a "new" field of research, many studies on beliefs can already be found. Perhaps the nature of studied subject led a way for researchers in choosing proper methods of research. The researchers used both qualitative and quantitative methods. The problem in retrieving data related to beliefs by using quantitative methods was explicit. Researchers using quantitative methods tried to overcome this problem by working on more and more reliable questionnaires or quantitative measurement tools. Previous studies on

teacher and student beliefs and beliefs about mathematics can be found in the following section.

2.2.2. Previous Studies on Beliefs

Many of the beliefs related to mathematics, its teaching and its learning are thought to be gained during early school experiences. Then when those students become teachers, their beliefs also affect future teachers. It seems as a vicious circle. Thus, teachers' beliefs are to be taken into account and to be considered seriously. Brickhouse (1990) researched teachers' beliefs about the nature of science and their relationships to classroom practice. This was a qualitative study realized by interviewing three science teachers. Each of these teachers' classes was observed for at least 35 hours. She examined the possible link between teachers' view of the growth of scientific knowledge and the methods they used to help students construct knowledge of science. The teachers who were the subjects of this study differed in their views of the nature of scientific theories, scientific processes, and the progression and change of scientific knowledge. Findings by this study also showed that, teachers' beliefs about science influenced the lessons directly related to the nature of science and these beliefs also shaped an implicit curriculum concerning the nature of scientific knowledge.

Deborah Loewenberg Ball seemed to be one of the most productive researchers in the field. Ball (1990) investigated 19 prospective elementary and secondary teachers' understanding of division. This study was a qualitative study.

The subjects interviewed when they were about to enroll for their first education course. Subjects of the study were asked to provide a reasonable justification of what they propose. Answers of the subjects in this study analyzed on some dimensions like subject matter understanding, ideas about teaching, learning and the teachers' role, and feelings or attitudes about mathematics, pupils or self. Since not only emotional but also cognitive approaches of subjects of the study investigated, interesting results about prospective teachers' beliefs were obtained. It is stated that in answering the questions, many of the teacher candidates 'agonized' over not having a concrete example or not knowing why something was true. It is proposed that these results could be taken as evidence that even correct answers had not been undergirded with legitimate mathematical warrants or with understanding. Findings by this study showed that the prospective teacher's knowledge was generally fragmented and cases of division were held as separate bits of knowledge in their minds.

A research on one of the most interesting questions in the field was realized by Brousseau and Freeman (1988). They researched the answer of the question: 'How do teacher education faculty members define desirable teacher beliefs?' They compared educational beliefs of 57 teacher education faculty members, which are also classified as 'desirable' by these faculty members themselves, with measures of educational beliefs from 896 entry-level teacher candidates. This was a quantitative study in which a questionnaire and a five point Likert scale were used. They found that faculty members think that most beliefs must be shaped in a particular way but

they disagree on that 'particular' way. They also found that faculty members were more likely to reinforce prevailing beliefs, which they think as appropriate, instead of challenging undesired beliefs of students.

It was previously noted that beliefs of teachers are mostly form during their early school experiences and this was referred as a vicious circle previously in this study. Teachers start to believe as their teachers used to believe. Raymond and Santos (1995) called the same thing as the chain of beliefs about mathematics, and proposed that individuals internalize such beliefs through continuous exposure to school and home situations that reinforce the notion that this is the true nature of mathematics. They discussed that prospective teachers should experience early and continuous challenges to beliefs so that they may become more aware of relationships between classroom experiences and beliefs. The researchers did their observations during a specifically designed mathematics content course, in which students were challenged to construct and/or reconstruct their understanding of mathematics and to communicate their experiences and what they were learning throughout the process. It was a qualitative study in which data were collected through observations, interviews, and document analysis. The analysis resulted in three thematic categories: beliefs about knowing, learning, and teaching mathematics; and the disequilibration process provoked by the specifically designed course. The researchers discussed that students may challenge their long-held mathematics beliefs, when they take control of their own learning and construct an understanding of mathematics. They suggested that keeping in mind that innovation

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

for the sake of innovation may be dangerous, confronting and challenging preservice teachers' beliefs should be an integral part of teacher education. Preservice teachers should be encouraged to reject on challenges that they constructed when they were exposed onto learning situations in which they experience disequilibration. The preservice teachers then can be expected to carry this process of questioning and redefining beliefs into their teaching practice.

After the importance of beliefs of Mathematics teachers in education was understood and widely recognized, some researchers focused on the ways of changing these beliefs. Steele and Widman (1997) dealt with this problem by looking from a constructivist point of view. They simply wanted to find out whether exposing students to alternative models of teaching (for example a constructivist model) changed their conceptions about mathematics and mathematics teaching and learning. They also wanted to know what the conceptual changes were if they exist. Their research approach was an ethnographic of participant observation, interviewing, and collecting artifacts. They stated that to ensure validity and reliability, which is a problem for these kind of studies, they collected data over a long period of time, used several methods for gathering data, discussed findings with classroom participants and keeping their bias under control. To address the issue of changing conceptions, the researcher taught a 15-week elementary mathematics method course based upon constructivist learning principles. The researcher at the beginning of the course and another teacher at the end of the course interviewed randomly selected five students, who were all female. The students were closely

observed; the researcher kept a journal that included students' responses to classroom activities and classroom interactions. All of the students' responses reflected a traditional view of mathematics before the course. They viewed mathematics as being numbers, right answers, and one correct way of solving problems. But by the end of the course they started questioning that traditional view. According to them these students were becoming mathematical thinkers and in doing so were changing their conceptions about the nature of mathematics. Other changes were as follows: The students learned to explore mathematics through discussing, started perceiving their roles as being 'guides'.

Another study about the mathematical beliefs of students was done by Alan H. Schoenfeld of University of California-Berkeley. Schoenfeld (1989) explored aspects of the relationship between students' beliefs about mathematics-their sense of mathematics as a discipline, and their relationship between students' understandings about the nature of deductive proof in plane geometry and other geometric endeavors was emphasized. The subjects of this study were 230 students (112 female, 118 male) who were enrolled in high school mathematics courses. For this study, a questionnaire containing 70 closed and 11 open questions was developed. It contained multiple-choice questions 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 and motivation. The results of this study were as follows: No significant sex differences

in attribution emerged from the data collected. It came out that, in general, the students seemed to consider mathematics to be an objective, and objectively graded, discipline that can be mastered. They also believed that it was work and not good luck that accounted for good grades, and they placed much more emphasis on work than on inherent talent; they believed that if the students do poorly, this is their own fault. One of the results especially showing the beliefs of student about teaching practice in mathematics was as follows: The students believe that the good teaching practice in mathematics, consists of making sure that students know how to use the rules and on the other hand, they also believe that good teaching practice consists of showing students lots of different ways to look at the same question. The results from the part related to motivators showed that both the students and their parents believe it is quite important for the students to do well in mathematics; the students work at the mathematics in large part because they want to do well in the course which is required in their programs, and they study mathematics for intrinsically valuable reasons (to think more clearly in general) rather than for extrinsic reasons like avoiding to look dumb or to impress teachers. The data showed that the students to be highly motivated, and their motivation seemed to spring from the right reasons like finding the subject matter interesting or being aware of the uses of the discipline. The students claimed that they were not motivated by the fears of looking stupid or getting into trouble or by the desire for their teachers to think they are good students. And there is one final finding in this study which is claimed as 'a dark side to the picture' by the author: Despite their assertions that mathematics helps one to think

logically and that one can be creative in mathematics, students claimed that mathematics is best learned by memorization, and in the case of memorization, they practiced what they claimed to believe.

Another study to understand the relationship among beliefs, practice and previous experiences was conducted by Glenda Carter and Karen S. Norwood (Carter & Norwood 1997). They examined 'the relationship between 7 teachers' beliefs about mathematics, the learning and teaching of mathematics, and their 158 respective students' beliefs about math. The students' statement scores were recorded so that higher scores reflected beliefs that were philosophically in line with the recommendations and goals of the National Council of Teachers of Mathematics Standards. The research question for this study was: 'Are the beliefs held by elementary teachers about teaching and learning mathematics reflected in their students' beliefs about mathematics?' Their results suggested that teacher beliefs about the teaching and learning of mathematics influenced the way in which their students are likely to view the learning of mathematics. Another suggestion by their results was that the teachers who hold beliefs more closely aligned with the 'Standards' of National Council of Teachers of Mathematics use practices in teaching that influence students' beliefs and serve to accentuate intellectual development. The researchers found no student differences for subscales of ego orientation, competitiveness, interest and extrinsic factors such as neatness and cooperation.

"It is hard to imagine teachers who are not intellectually alive and thoughtful about their work being able to challenge student to think critically and creatively. If teachers are not the thinkers we might wish them to be, then teacher educators are right to be concerned about how preservice programs can promote more thoughtful approaches to teaching (Bolin, 1988, p.48)."

His study was based on a case study of one preservice teacher. Interviews with this preservice teacher's supervisor and additional documents (autobiography and student teaching evaluations) were used to supplement the journal data and discover confirming or disconfirming evidence. He stated that student teachers bring with them what was likely to be a latent philosophy of education and this philosophy might be tempered by student teaching, but remains largely unchanged by the experience. Student teachers may not have articulated a philosophy of education, nor are they likely to be aware of its sources. Students must become conscious of their own taken-for-granted philosophy of education and attempt to understand how they have arrived at it in order to adequately critique and develop it.

Possibly elementary schools are the first places people face formal ways of mathematics where their beliefs about mathematics start forming. In the study of beliefs, student beliefs becomes stating that relatively less research had been conducted on the beliefs and attitudes toward mathematics among elementary-level

students Vanayan, White, Yuen and Teper (1977) realized a research on elementary school students. Approximately 2750 students were randomly selected from sixty randomly selected coeducational schools. One of the most important findings in this study was that more boys consider themselves 'to be good' at mathematics than girls even though no gender differences were observed on many other variables. This result has been often reported for older students but has rarely been explored in young children. They found no gender differences in students' perceptions concerning the relevance of mathematics, which was a finding, which was not consistent with reports from older students.

Today in almost every teacher education program whether short or long, there is an early field experience period. During this period of their education, prospective teachers find an opportunity to practice the theory they were taught. This practice is also very important since the prospective teachers see the school setting and professional teachers with 'teacher' eyes and observe them. This is also the first time that the beliefs of these young teachers start affecting their teaching practice. Many researchers stated that a real, effective reform in mathematics education required a change of beliefs. But what if the beliefs of prospective teachers' are challenged during their early field experience? McDiarmid (1990) and tried to find an answer to this question. He stated that teacher educators who teach courses including field experiences faces a dilemma: On the one hand, experiences in school classrooms are memorable, powerful and considered as very credible by prospective teachers. On the other hand, what students observe serves to confirm their faith in the folkways of

teaching and their faulty perceptions and judgments (maybe beliefs) are supported, even rewarded by trusted professional teachers. In order to outcome this problem the author selected an extraordinary professional who teaches in ways that were likely to challenge the prospective teachers' assumptions and beliefs. The prospective teachers discussed, wrote notes about operations with positive and negative numbers, which is the topic that will be taught by the selected teacher. They interviewed with the selected teacher before and after each class they observed about purposes goals, plans, reactions of the teacher and the rationale for her actions. At last they wrote a "case study" of the teaching and learning of operations with positive and negative numbers. What was the result then? Some students (prospective teachers) openly resisted the implication of their experience. They stated that their case was an atypical one and gifted students are required for such a case. Other student who are willing to reexamine their beliefs were not ready to transfer the lessons they learned about the teaching and learning of mathematics to other subjects. Many of these students realized the inadequacy of their knowledge and consoled themselves with the belief that they would acquire the required knowledge 'on the fly' when they become real teachers. McDiarmid (1990) stated that he was skeptical about the effects of this course since the strength of each individual belief about teaching, learning, learners, subject matter knowledge, and context was formidable. Challenging beliefs is a really difficult thing to do because beliefs constitute belief systems just like strands constitute a web of a spider. Interwoven, the strands

constitute a web of remarkable resilience and severing one strand does not diminish the overall strength of the whole.

Alba Gonzales- Thompson is one of the most cited researchers studying beliefs. His studies in early 80's led many researchers. In those days, he stated that the questions of how teachers integrate their knowledge of mathematics into instructions, practice and what role their conception of mathematics might play in teaching have largely been ignored, and he conducted case studies to focus on this matter (Thompson, 1984). The subjects of this study were three junior high school mathematics teachers. For four weeks each of the teachers were observed daily. During the last two weeks in addition to observations, daily interviews were conducted after the observed lesson. In a cross-sectional analysis section, the author looked across the teachers, examining the aspects of their conceptions and behavior on which they differed most markedly: Differences in the specific elements of the teachers' conceptions of mathematics and mathematics teaching, in the integratedness of the teachers' conceptions, in the teachers' reflectiveness on their instructional actions (which were explained previously in the theoretical background section), the subject matter, and their beliefs. The author stated that his study was a first step in a line of research whose ultimate goal is to identify key factors that, because of their influence on teachers' educational practice, may play an important role in their teaching effectiveness. His study showed that the teachers' 'conceptions', which is used as an alias for 'beliefs' here, are not related in a simple way to their instructional decisions and behavior. Instead, the relationship is very complex. Together with

many other factors, beliefs about teaching that are not specific to mathematics, appear to interact with the teachers' conceptions of mathematics and its teaching affecting their decisions and behavior. The findings of this study also showed that teachers' beliefs, views and preferences about mathematics and its teaching, regardless of whether they are consciously or unconsciously held, play a significant, albeit subtle, role in shaping the teachers' characteristic patterns of instructional behavior.

In his study Pajares (1990) stated that the construct of 'beliefs' is messy and should be cleaned up and he wrote that beliefs are commonly investigated under many different aliases. Among, many aliases he stated one was extremely important because of its very common usage: attitudes. In an effort for discriminating these two concepts, Bem (1970) wrote that 'attitudes are likes and dislikes'. For example, a questionnaire item like 'Do you like mathematics?' measures attitudes whereas an item such as 'Do you think that the mathematics you are taking is useful?' measures beliefs. In many questionnaires, attitude scales, both types of items can be found together. So during a literature review for beliefs about mathematics, research studies dealing with 'attitudes' become interesting ones that should be taken into consideration.

Stemback and Gwizdala (1995) had an opportunity to research gender differences in mathematics "attitudes" of secondary students when they were in single-sex schools and when they were in mixed-sex schools. In 1986 after an all-female Catholic secondary school had announced that it would become a mixed-sex

school after a year, the researchers had a 'unique' opportunity to investigate student 'attitudes' in mathematics before and after the change in the school environment. They wrote that traditional male/female differences were found in the areas of self-confidence usefulness of mathematics, and classroom behavior. Female students who participated in both years of the investigation remained overall unchanged. The inclusion of males in the school and the mathematics classroom in particular did not change female students' attitudes after only one year. The male students reported the changes in the classroom as "girls are not as smart as boys so they need more help from the teacher", "girls are distraction", "want to impress the girls", "teachers consider the boys smarter", and "the teacher no longer tells dirty jokes". In addition to stating "teachers consider the boys smarter" just like girls do, male students perceive that "boys are smarter". In general female students 'attitudes related to mathematics remained positive.

Gender difference in outcomes of mathematics education is a widely researched and studied concept. After the concept of 'beliefs' became an important field of study, researchers tried to find connections or bounds between the sources of gender differences and the beliefs of educators. Fennema, Peterson, Carpenter and Lubisnski (1990) in their study titled 'Teachers' attributions and beliefs about girls, boys, and mathematics', tried to find out if evidence could be provided for such a connection. They used both qualitative and quantitative methods for the study. Thirty-eight first grade female teachers in 24 schools in the United States were asked to report their two most and least successful girls and boys in mathematics, to give

reasons for these students' successes and failures and to describe characteristics of these reasons, or causes. Information related to teachers' beliefs about successful and unsuccessful students and their explanations about the causes of these was gathered by means of qualitative methods. Interviews with the teachers were done by trained interviewers. For gathering the information about teachers' beliefs concerning the characteristics of their best mathematics students a questionnaire was used. And mathematics achievement of students was measured by a group-administered test. Students' test scores were compared to teachers' choices of most and least successful students. Results of this comparison showed that teachers were most inaccurate when selecting most successful boys. When it came to reasons for success and failure, teachers tended to attribute causation of boys' success and failures to ability and girls' success and failures to effort. It came out that teachers believed that their best boy students when compared to their best girl students, were more competitive, more logical, more adventurous, volunteered answers more often to mathematics problems, enjoyed math more, and were more independent in mathematics.

Brousseau, Book and Byers (1988) described and contrasted the beliefs of experienced teachers and the students in undergraduate teacher preparation programs in Michigan State University. They presented their reason for working on such a subject in their view, a first step toward understanding how to affect the process of schooling would be to understand the values and beliefs of those who drive these processes. Pointing the dangers in glorifying teacher beliefs simply because they are what teachers believe, they proposed that their study would illustrate these dangers of

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

accepting the beliefs of experienced teachers as a standard for prospective teachers to work forward.

Brousseau, Book and Byers (1988) studied with a group of 391, second year students, a group of 332 senior students, a group of 382 full time classroom teachers in Michigan, and a group of 90 teacher education graduates. They used three surveys containing items from different sources like previous studies and contributions by individual faculty members. They used Likert-scale for measurement. Findings were that the more experienced teachers had been more likely to believe that their students had been trustworthy, that there should be common standards for all, and that schools should act like change agents. This study, on the other hand showed that as the classroom teaching experience increases, a common curriculum was more favored and the teacher's sense of self-efficacy was growing weaker.

There are also some studies on pupils' beliefs about mathematics and mathematics teaching. Since there is strong evidence that most of, the beliefs formed during early school experiences, these studies focus on current pupils' beliefs. 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: 'Good mathematics teaching includes....' For their quantitative study a total number of 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 a belief in the existence of proper procedures.

Austin and Wadlington (1992) investigated the effects of mathematics beliefs on math anxiety and math self-concept of college students. Fifty preservice and 15 in-service teachers participated in their study. After defining math anxiety as "a year of mathematics or an intense, negative emotional reaction to anything remotely mathematical", they stated that it was not the only reason for lowered math scores in the United States but it was a very important one. Three different questionnaires, mathematics anxiety rating scale, mathematics self-concept test and a specially developed test were prepared for the study. The math belief survey was used as a measuring instrument. Despite the suggestions by earlier studies that a relationship exists between math anxiety and negative math self concept, such a relationship could not be found in this study. But a significant difference found between the high and low math anxiety preservice mathematics teachers on math self-concept, which was consistent with other findings. The researchers were satisfied with the teachers' comments about the foundations upon which their beliefs were based. Their comments also indicated that previous experiences, including those in elementary school, contributed to teachers' ideas about how mathematics is done.

Erickson (1993) researched middle school mathematics teachers' views of mathematics and mathematics education using qualitative research method. This was

a case study in which four professional, experienced middle school mathematics teachers were chosen as subjects. Instrumentation for this study seems to be very detailed. Teacher questionnaires in which teachers gave explanations about their definitions of mathematics and indicated their views about the main purposes of public school education were used as a first part of instrumentation. One-hour teacher interviews were a second part. These interviews were conducted two times and were including discussion of the goals for teaching what they teach and teachers' views about the general purpose for education and a more particular purpose for studying mathematics in middle school. Middle school mathematics teachers were asked to make a yearlong curriculum plan for their classes and mini lesson plans detailing how they would translate their curriculum plans into action. Teachers also kept a weekly journal. In addition to all these, teachers made between zero and five videotapes of their classes. Finally, as a last part of the instrumentation student questionnaires for learning student demographic data, perceptions/beliefs toward mathematics, favorite classes, and future uses for mathematics used. There were also student achievement tests developed by the researcher. The most important suggestion of the author of this study can be stated as follows: In service teacher education programs should provide for discussion of alternative views of mathematics and philosophy of education. She stated that if the mathematics we are recommended to teach, and the way we are asked to teach it is different from what most mathematics teachers have experienced themselves, then time should be allotted for reading, thought, and discussion within methods courses both at the in-

service level, as well as the preservice level, about a broadened perspective of mathematics.

The main problem of the present study was "What are the beliefs of preservice mathematics teachers at the Middle East Technical University and the Gazi University about the nature of mathematics, and the teaching of mathematics?"

In this chapter both the previous studies related to theory of beliefs and the previous research studies on beliefs and the results proposed by them were presented.

CHAPTER 3

METHOD OF THE STUDY

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

3.1 Problems of the Present Study and Associated Hypotheses

In the previous chapters, the theoretical background and previous research studies in the literature relevant to the present study on the beliefs of mathematics teachers and students and their effects on education were described.

In this section, the main and related sub-problems and the hypotheses relevant to these problems are stated.

The main problem of the present study is as follows:

"What are the beliefs of preservice mathematics teachers at the Middle East Technical University and the Gazi University about the nature of mathematics, and the teaching of mathematics?"

Based on the main problem, the following sub-problems are explored:

- **Sub-problem 1:** Is there any statistically significant difference between the mean scores of preservice mathematics teachers at the Middle East Technical University and the Gazi University in terms of the nature of mathematics?
- **Sub-problem 2:** Is there any statistically significant difference between the mean scores of preservice mathematics teachers at the Middle East Technical University and the Gazi University in terms of the teaching of mathematics?
- **Sub-problem 3:** Is there any statistically significant difference between the mean scores of girls and boys in terms of the nature of mathematics?
- **Sub-problem 4:** Is there any statistically significant difference between the mean scores of girls and boys in terms of the teaching of mathematics?
- **Sub-problem 5:** Is there any statistically significant relationship between the beliefs of preservice mathematics teachers at the Middle East Technical University and the Gazi University about the nature of mathematics and about the teaching of mathematics?

The following null hypotheses are stated in order to investigate the sub-problems. They are tested at the significance level 0.05.

The hypothesis of the first sub-problem:

- ***$H_0 1$:*** There is no statistically significant difference between the mean scores of preservice mathematics teachers at the METU and those at the Gazi University in terms of beliefs about the nature of mathematics.

The hypothesis of the second sub-problem:

- ***$H_0 2$:*** There is no statistically significant difference between the mean scores of preservice mathematics teachers at the METU and those at the Gazi University in terms of beliefs about the teaching of mathematics.

The hypothesis of the third sub-problem:

- ***$H_0 3$:*** There is no statistically significant difference between the mean scores of girls and boys in terms of beliefs about the nature of mathematics.

The hypothesis of the fourth sub-problem:

- ***$H_0 4$:*** There is no statistically significant difference between the mean scores of girls and boys in terms of beliefs about the teaching of mathematics.

The hypotheses of the fifth sub-problem:

- ***$H_0$5.1:*** There is no statistically significant relationship between the beliefs of preservice mathematics teachers at the Middle East Technical University and the Gazi University about the nature of mathematics and about the teaching of mathematics.
- ***$H_0$5.2:*** There is no statistically significant relationship between the belief that mathematics has no effect on cognitive development and the belief that it is not teachers' responsibility to provide the students understand mathematics.
- ***$H_0$5.3:*** There is no statistically significant relationship between the belief that mathematics is a language and the belief that usage of analogies, metaphors, and symbolic expressions should be encouraged.
- ***$H_0$5.4:*** There is no statistically significant relationship between the belief that mathematics is a language and the belief that efforts should be made in order to help students acquire the ability to make connections between other fields and mathematics.
- ***$H_0$5.5:*** There is no statistically significant relationship between the belief that mathematics is a subject that concerns everybody, and the belief that students should be explained why mathematics is taught.

- ***$H_0$5.6:*** There is no statistically significant relationship between the belief that mathematics is a science that explains natural events using numbers, and the belief that students should be explained why mathematics is taught.
- ***$H_0$5.7:*** There is no statistically significant relationship between the belief that mathematics is a science that explains natural events using numbers, and the belief that usage of analogies, metaphors, and symbolic expressions should be encouraged.
- ***$H_0$5.8:*** There is no statistically significant relationship between the belief that mathematics helps people develop their problem solving abilities, and the belief that students should be helped to acquire problem-solving skills using various strategies.
- ***$H_0$5.9:*** There is no statistically significant relationship between the belief that mathematics helps people develop their problem solving abilities, and the belief that importance should be given to problem solving methods including understanding the problem, making a plan, carry out a plan and check
- ***$H_0$5.10:*** There is no statistically significant relationship between the belief that mathematics is an art like poetry or music, and the belief that studies should be realized to help students acquire the ability to make connections between other fields and mathematics.

- ***$H_0$5.11:*** There is no statistically significant relationship between the belief that mathematics is an art like poetry or music, and the belief that the value of mathematics in society and in other fields should be taught by showing the applications of it
- ***$H_0$5.12:*** There is no statistically significant relationship between the belief that mathematics is an art like poetry or music, and the belief that terms and symbols proposed by students should be used besides conventional terms and symbols.
- ***$H_0$5.13:*** There is no statistically significant relationship between the belief that mathematics is an art like poetry or music, and the belief that other methods than traditional methods should be used in mathematics classrooms.
- ***$H_0$5.14:*** There is no statistically significant relationship between the belief that mathematics is a science that only deals with numbers, and the belief that it is not necessary to dwell upon problems taken from real life.
- ***$H_0$5.15:*** There is no statistically significant relationship between the belief that mathematics is a way of thinking that human beings develop when they solve the problems they face in real life, and the belief that students should be helped to acquire problem-solving skills using various strategies.

- ***$H_0$5.16:*** There is no statistically significant relationship between the belief that mathematics is a way of thinking that human beings develop when they solve the problems they face in real life, and the belief that it is not necessary to dwell upon problems taken from real life.

- ***$H_0$5.17:*** There is no statistically significant relationship between the belief that mathematics is a way of thinking that human beings develop when they solve the problems they face in real life, and the belief that importance should be given to problem solving methods including understanding the problem, making a plan, carry out a plan and check.

- ***$H_0$5.18:*** There is no statistically significant relationship between the belief that mathematics is a way of thinking that human beings develop when they solve the problems they face in real life, and the belief that real life examples cannot be found in most subjects of the mathematics.

- ***$H_0$5.19:*** There is no statistically significant relationship between the belief that mathematics is a way of thinking that human beings develop when they solve the problems they face in real life, and the belief that mathematics teacher should explain the historical development process of the subject.

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

- ***$H_0$5.20:*** There is no statistically significant relationship between the belief that mathematics is not a need for society, and the belief that ways of thinking mathematically should be taught.
- ***$H_0$5.21:*** There is no statistically significant relationship between the belief that mathematics makes life easier, and the belief that students should be acquired the skills of problem solving using different strategies.
- ***$H_0$5.22:*** There is no statistically significant relationship between the belief that mathematics makes life easier, and the belief that importance should be given to problem solving methods including understanding the problem, making a plan, carry out a plan and check.
- ***$H_0$5.23:*** There is no statistically significant relationship between the belief that mathematics makes life easier, and the belief that the shortcuts and practical methods, which are used to find the solution quickly, should not be taught.
- ***$H_0$5.24:*** There is no statistically significant relationship between the belief that mathematics is a tool used for the development of the civilization, and the belief that, teacher should strive for changing the students' point of view about mathematics in a positive direction.

- ***$H_0$5.25:*** There is no statistically significant relationship between the belief that mathematics requires logic but not intuition, and the belief that, teacher should attach importance on guessing results.

- ***$H_0$5.26:*** There is no statistically significant relationship between the belief that there is no room for creativity in mathematics, and the belief that, teacher should attach importance and listen to the students' opinions about the subject that is being told.

- ***$H_0$5.27:*** There is no statistically significant relationship between the belief that there is no room for creativity in mathematics and the belief that beside the usage of conventional terms and symbols, usage of terms and symbols proposed by students should be encouraged.

- ***$H_0$5.28:*** There is no statistically significant relationship between the belief that mathematics help people acquire logical thinking ability, and the belief that importance should be attached to teaching of mathematical way of thinking.

- ***$H_0$5.29:*** There is no statistically significant relationship between the belief that mathematics is a tool that helps other branches of science develop, and the belief that studies should be realized to help students acquire the ability to make connections between other fields and mathematics.

3.2 Research Design

For this study the survey research techniques were utilized. Three major characteristics of a survey research can be found in this study (Fraenkel & Wallen, 1996a):

- Information was collected from a group of preservice mathematics teachers in order to describe their beliefs.
- The main way used in collecting the information was asking questions. The answers to these questions by the preservice mathematics teachers constituted the data of the study.
- Information was collected from a sample rather than from every member of the population.

Of the two different types of survey researches, the present study was a "cross-sectional survey". Since the major purpose of these types of surveys is to describe the characteristics (beliefs) of the subjects, why the observed distribution existed as what the distribution was not of concern. A cross-sectional survey collects information from a sample that has been drawn from a predetermined population and the information is collected at just one point in time (Fraenkel & Wallen, 1996a).

3.3 Subjects of the Study

The subjects of the present study consisted of 79 senior students (preservice mathematics teachers) enrolled at mathematics teacher education programs of Gazi University and Middle East Technical University in Ankara-Turkey. Forty of these pre-service teachers are from Middle East Technical University and thirty-nine of them are from Gazi University. Fifty-four of the subjects were boys and twenty-five were girls. For the present study, convenience-sampling was used to select subjects.

3.4 Definition of Terms

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

Beliefs: What are referred as "beliefs" here is an individual's conceptions, values, ideology, dispositions, philosophies of life and philosophies of mathematics.

Nature of mathematics: All qualities of mathematics from doing it to understanding it.

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

3.5 Measuring Instruments

In the present study two specially developed tests by the researcher was used:

a) Beliefs about the Nature of Mathematics Scale (BaNoM) (See Appendix A);

b) Beliefs about the Teaching of Mathematics Scale (BaToM) (See Appendix B).

3.5.1 Beliefs about the Nature of Mathematics Scale (BaNoM):

BaNoM was developed by the researchers. The scale was used to determine preservice mathematics teachers' beliefs about nature of mathematics.

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

1. The item pool for BaNoM was derived from (a) literature beliefs about the nature of mathematics (b) National Council of Teachers of Mathematics Standards (1989, 1991); (c) Journals written by preservice mathematics teachers; and (d) observations of people's beliefs about the nature of mathematics. The item pool consisted of 65 items related to beliefs about the nature of mathematics. All items were written in Turkish to minimize misunderstanding and to administer students enrolled at the mathematics teacher education programs whose medium of instruction is in Turkish. From this item pool, twenty-five items were selected. The

others were eliminated since it has decided that they were measuring attitudes instead of beliefs.

2. BaNoM administered to 159 mathematics education students enrolled at the Middle East Technical University (83) and Selçuk University (76) in the Fall Semester of the 1998-1999 academic year.

3. Data was analyzed by using the "Statistical Packages for Social Sciences" (SPSS). The BaNoM with 25 items was scaled on a six-point Likert Type scale: Strongly Agree, Agree, Tend to Agree, Tend to Disagree, Disagree, Strongly Disagree. The positively worded items were scored starting from Strongly Agree as 6, to strongly disagree as 1, and negatively worded items were reversed to a positive direction for scoring purposes. This six-point scale was used to disallow the undecided response in five-point scales.

4. To test the construct validity of BaNoM and to find its sub dimensions, factor analysis was done. According to the initial principal factor solution with iterations, the first nine eigenvalues were 3.818, 2.631, 1.587, 1.473, 1.298, 1.235, 1.198, 1.141, and 1.045. The first factor accounted for 15.272 % of the total variation in BaNoM scores. 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 2.445, 2.195, 1.992, 1.918, 1.520, 1.484, 1.364, 1.307, and 1.200. The first factor explained 9.778% of the variation of total scores of BaNoM.

After the examination of the loadings from initial and varimax rotated factor analysis, 9 items were deleted because their factor loadings were very low. Hence, factor analysis was done again with 16 items. The loadings from initial and varimax rotated factor solutions supported that BaNoM was unidimensional providing the evidence for construct validity of BaNoM. The single factor was named "general belief about the nature of mathematics". The content validity of BaNoM was also checked by a mathematics education researcher.

The alpha reliability coefficient of BaNoM with 16 items was found as 0.63 with the SPSS package program. The total score of BaNoM was between 16 and 96.

3.5.2 Beliefs about the Teaching of Mathematics Scale (BaToM):

BaToM was developed by the researchers. The scale was used to determine preservice mathematics teachers' beliefs about nature of mathematics.

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

1. The item pool for BaToM was derived from (a) literature beliefs about the nature of mathematics (b) National Council of Teachers of Mathematics Standards (1989,1992); and (c) observations of people's beliefs about the teaching of mathematics. The item pool consisted of 80 items related to beliefs about the nature of mathematics. All items were written in Turkish to minimize misunderstanding and to administer students enrolled at the mathematics teacher education programs whose

medium of instruction is in Turkish. From this item pool, Thirty-nine items were selected because they seemed appropriate and enough to the researcher.

2. BaToM administered to 159 mathematics education students enrolled at the Middle East Technical University (83) and Selçuk University (76) in the Fall Semester of the 1998-1999 academic year.

3. Data was analyzed by using the "Statistical Packages for Social Sciences" (SPSS). The BaToM with 39 items was scaled on a six-point Likert Type scale: Strongly Agree, Agree, Tend to Agree, Tend to Disagree, Disagree, Strongly Disagree. The positively worded items were scored starting from Strongly Agree as 6, to strongly disagree as 1, and negatively worded items were reversed to a positive direction for scoring purposes. This six-point scale was used to disallow the undecided response in five-point scales.

4. To test the construct validity of BaToM and to find its sub dimensions, factor analysis was done. According to the initial principal factor solution with iterations, the first twelve eigenvalues were 8.828, 3.014, 2.088, 1.849, 1.644, 1.484, 1.369, 1.270, 1.247, 1,106, 1.083, and 1.076 . The first factor accounted for 22.636 % of the total variation in BaToM scores. 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 7.406, 2.382, 2.228, 1.884, 1.728, 1.647, 1.541, 1.499, 1.493, 1.475, 1.447, and 1.328. The first factor explained 18.990% of the variation of total scores of BaToM.

After the examination of the loadings from initial and varimax rotated factor solutions, 6 items were deleted because their factor loadings were very low. The loadings from initial and varimax rotated factor solutions supported that BaToM was unidimensional providing the evidence for construct validity of BaToM. The single factor was named "general belief about the teaching of mathematics".

The alpha reliability coefficient of the BaToM with 33 items was found as 0.82 with the SPSS package program. One item, related to usage of discussion method in mathematics classrooms was added to this scale which was considered as a necessary item. Because there were items in the scale related to other basic teaching methods like lecture, discovery learning, problem solving, cooperative learning, were added before but an item related to discussion method was missing.

After the analysis of the pilot study, reliability analysis was done with 73 preservice mathematics teachers at the METU and the Gazi University. The alpha reliability coefficient of the BaToM with 34 items was found as 0.84 with the SPSS package program. Factor analysis was not accomplished with new data because the number of subject was not enough and according to the results of the pilot study BaToM was unidimensional clearly. Addition of one item to the scale could not change this situation. The content validity of BaToM was also checked by a mathematics education researcher.

The total score of BaToM was between 34 and 204.

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

3.6 Procedure

The present study was conducted during the spring semester of 1999-2000 academic year. Almost all the seniors who enrolled at the Mathematics Education Programs of Middle East Technical University and Gazi University and who had been taking the "teaching practice" courses, answered BaToM and BaNoM scales. The subjects were given one hour for completely filling the scale up. The scale was administered by the researcher.

3.7 Data Analysis

Data of the present study were analyzed by the following statistical techniques. Reliability analysis was used to test the reliability of "Beliefs about the Nature of Mathematics Scale (BaNoM)" and "Beliefs about the Teaching of Mathematics Scale (BaToM)" administrated in the present study. Factor Analysis was used to test the validity of these scales. T-test was used to test the differences between mean scores of girls and boys in terms of beliefs about the nature of mathematics and the teaching of mathematics. T-test was also used to test the differences between mean scores of preservice mathematics teachers at the Middle East Technical University and the Gazi University in terms of the nature of mathematics and the teaching of mathematics.

Pearson correlation was used to test the relationship between beliefs of the preservice mathematics teachers about the nature of mathematics and the teaching of

mathematics. It was also used to test the relationship among some of the items in the BaNoM and the BaToM. To analyze these items in more detail, their frequencies and percentages were computed.

Data of the present study were analyzed by using the SPSS package program.

3.8 Assumptions and Limitations

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

3.8.1 Assumptions

The main assumptions of the present study are the following:

- There was no interaction between the subjects from Middle East Technical University and Gazi University to affect the results of the present study.
- 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.

3.8.2 Limitations

The limitations of the present study are as listed below:

- This study was limited to seniors enrolled at the Mathematics Education Programs at the Middle East Technical University and the Gazi University during the spring semester of the 1999-2000 academic year.
- Self-report techniques, which require the subject to respond truthfully and willingly, were used.
- The use of questionnaire alone could not give a complete picture of preservice mathematics teachers' beliefs but it gave access to their surface beliefs. For reaching the subjects' deep beliefs, the collection of data should also include other methods like interviews. On the other hand, Pehkonen and Tompa (1994) stated that the questionnaire method gives a good first approximation of the subjects' beliefs and this was one of the exact purposes of this study.

3.9 Validity of the Present Study

In this section validity of the present study is discussed.

3.9.1 Internal Validity

By internal validity, it is meant that observed differences on the dependent variable are directly related to the independent variable, and due to some unintended variable (Fraenkel & Wallen, 1996a). There were possible threats to internal validity in this study. Subject characteristics, location, data collector characteristics, data collector bias were such threats. The ways of controlling these treats were discussed.

In the present study, subject characteristics could be a problem for the internal validity. 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, those characteristics did not affect research results unintentionally. Just like gender, location was a controlled variable. Two of the sub-problems and related hypotheses were about the differences in beliefs springing from the difference in locations.

Data collector characteristics and data collector bias should not be threats for this study since the data collector (the researcher) followed the same procedure at the Middle East Technical University and the Gazi University.

3.9.2 External Validity

In this section, population validity and ecological validity of the present study is discussed.

3.9.2.1 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.

3.9.2.2 Ecological Validity

The ecological validity is the degree to which results of a study can be extended to other setting or conditions (Fraenkel & Wallen, 1996a). The measuring instruments were utilized in university setting. Since the study is on preservice mathematics teachers, the results of the present study can be generalized to similar settings to this study.

CHAPTER 4

RESULTS AND DISCUSSIONS

In this chapter the results are presented and discussed.

The purpose of the present study was to investigate the beliefs of preservice mathematics teachers at the Middle East Technical University and the Gazi University about the nature of mathematics and the teaching of mathematics. The design of the present study is cross-sectional survey. According to Fraenkel and Wallen (1996a), generally in descriptive surveys (like the present study) the reasons why the observed distribution exist in a particular direction is not of concern for the researcher. Investigation of those reasons can be subjects of further studies. Hence in the present study we take their ideas into account and not the long explanations for them.

Hypotheses of the present study were tested on a six-point scale where 6 means "strongly agree"; 5 means "agree"; 4 means "tend to agree"; 3 means "tend to disagree"; 2 means "disagree" ; and 1 means "strongly disagree".

4.1 Results and Discussion of the Hypothesis of the First Sub-Problem

The first sub-problem was stated, as "Is there any statistically significant difference between the mean scores of preservice mathematics teachers at the Middle East Technical University and the Gazi University in terms of the nature of mathematics?"

The hypothesis of the first sub-problem ($H_0 1$) is: "There is no statistically significant difference between the mean scores of preservice mathematics teachers at the METU and those at the Gazi University in terms of beliefs about the nature of mathematics (BaNoM)."

After testing the hypothesis $H_0 1$ by using t-test at the significance level 0.05, as seen in Table 4.1, there is a statistically significant difference between the mean scores of preservice mathematics teachers at the METU and those at the Gazi University in terms of beliefs about the nature of mathematics ($p<0.05$). The results are given in Table 4.1.

Table 4.1 Comparison of Mean Scores of Preservice Mathematics Teachers at the METU and those at the Gazi in terms of BaNoM

Variable	Group	N	Mean	SD	Df	t-value
	METU	37	79.703	6.346		
BaNoM					69	2.383 *
	GAZİ	34	76.118	6.319		

(*) $p<0.05$

As seen on Table 4.1 there exists a slight difference between the mean scores of the preservice mathematics teachers at the METU and the Gazi University. A reason for this slight difference may be the different durations of practice teaching in the schools in these two universities. Preservice mathematics teachers in the Gazi University take "Teaching Practice" course for only one semester whereas the preservice mathematics teachers at the METU take "School Experience" and "Teaching Practice" courses for two semesters. This finding supports Vanayan, White, Yuen and Teper's (1977) ideas. The preservice mathematics teachers' practices in school are very important since the prospective teachers see the school setting and professional teachers with 'teacher' eyes and observe them and it is also the first time that the beliefs of these young teachers start affecting their teaching practice (Vanayan, White, Yuen & Teper, 1977). Certainly the mean difference between the universities cannot be explained by only one factor. For explaining this difference more detailed research studies are required.

4.2 Results and Discussion of the Hypothesis of the Second Sub-Problem

The second sub-problem was stated, as "Is there any statistically significant difference between the mean scores of preservice mathematics teachers in Gazi University and Middle East Technical University in terms of the teaching of mathematics?"

The hypothesis of the second sub-problem ($H_0$2) is: "There is no statistically significant difference between the mean scores of preservice mathematics teachers at the METU and those at the Gazi University in terms of beliefs about the teaching of mathematics (BaToM)."

After testing the hypothesis $H_0$2 by using t-test at the significance level 0.05, as seen in Table 4.2, there is a statistically significant difference between the mean scores of preservice mathematics teachers at the METU and those at the Gazi University in terms of beliefs about the teaching of mathematics ($p<0.05$). The results are given in Table 4.2.

Table 4.2 Comparison of Mean Scores of Preservice mathematics teachers at the METU and the Gazi University in terms of BaToM

Variable	Group	N	Mean	SD	Df	t-value
BaToM	METU	37	170.324	9.981	69	3.968 *
	GAZİ	34	158.882	14.118		

(*) $p<0.05$

For this differance, again the different duration of practice teaching courses in two universities can be given. Teaching practice is the most important experience the preservice teachers had and it affects their beliefs on teaching of math as well as their beliefs about nature of math.

4.3 Results and Discussion of the Hypothesis of the Third Sub-Problem

The third sub-problem was stated, as: "Is there any statistically significant difference between the mean scores of girls and boys in terms of beliefs about the nature of mathematics (BaNoM)?"

The hypothesis of the third sub-problem (H_03) is: "There is no statistically significant difference between the mean scores of girls and boys in terms of beliefs about the nature of mathematics (BaNoM)."

After testing the hypothesis ($H_0$3) by using the t-test at the significance level 0.05, as seen in Table 1.3, there is no statistically significant difference between the mean scores of girls and boys in terms of beliefs about the nature of mathematics ($p > 0.05$). The results are given in Table 4.3.

Table 4.3 Comparison of Mean Scores of Girls and Boys in terms of BaNoM

Variable	Group	N	Mean	SD	Df	t-value
	Girls	23	78.783	6.223		
BaNoM					69	0.708
	Boys	48	77.604	6.719		

4.4 Results and Discussion of the hypothesis of the Fourth Sub-Problem

The fourth sub-problem was stated, as "Is there any statistically significant difference between the mean scores of girls and boys in terms of beliefs about the teaching of mathematics (BaToM)?"

The hypothesis of the fourth sub-problem (H_04) is: "There is no statistically significant difference between the mean scores of girls and boys in terms of beliefs about the teaching of mathematics (BaToM)."

After testing the $H_0$4 by using t-test at the significance level 0.05, as seen in Table 4.4, there is no statistically significant difference between the mean scores of girls and boys in terms of beliefs about the teaching of mathematics ($p>0.05$). The results are given in Table 4.4.

Table 4.4 Comparison of Mean Scores of Girls and Boys in terms of BaToM

Variable	Group	N	Mean	SD	Df	t-value
BaToM	Girls	23	166.522	11.959	69	0.730
	Boys	48	164.042	14.118		

4.5 Results and Discussion of the Hypotheses of the Fifth Sub-Problem

The fifth sub-problem was stated, as: "Is there any statistically significant relationship between the beliefs of preservice mathematics teachers in Gazi University and Middle East Technical University about the nature of mathematics and about the teaching of mathematics?" The hypotheses of the fifth sub-problem are tested by using Pearson correlation at the significance level 0.05.

As explained in previous chapters, belief systems constitute a web like a spider web. Each belief is somehow connected to another in the belief system of every individual. Of the tests applied for this study, one was named as "Beliefs about the nature of mathematics" and the other one was named as "Beliefs about the teaching of mathematics". 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.

Below are some tables showing the correlations between some beliefs from BaNoM and BaToM and their interpretations. The tables below show the frequencies and percentages of some items in the BaNoM and BaToM by using a three-point scale in which "1" in this scale includes "strongly disagree" and "disagree", "2" includes "tend to agree" and "tend to disagree" and finally "3" includes "strongly agree" and "agree". We utilized a three point-scale in order to increase the number of subjects in the corresponding cells to interpret the findings.

Some of the items were eliminated in this phase of the study. The aim was to find related beliefs from BaToM and BaNoM. Obviously all of the items were not related. So in this part of the study, some items were selected.

The first hypothesis of the fifth sub-problem ($H_0 5.1$) is: "There is no statistically significant relationship between the beliefs of preservice mathematics teachers at the Middle East Technical University and the Gazi University about the nature of mathematics and about the teaching of mathematics."

After testing the hypothesis 5.1, it is found that there is a statistically significant relationship between the beliefs of preservice mathematics teachers at the Middle East Technical University and the Gazi University about the nature of mathematics and about the teaching of mathematics($r = 0.590$, $p < 0.05$).

The finding of the present study is supported by Raymond and Santos (1995) and Manouchehri (1997). Raymond and Santos (1995) stated that teacher beliefs about what mathematics was and what it meant to know, do, and teach mathematics may be driving forces in instruction of mathematical ideas. Manouchehri (1997) stated that the ways that teachers teach and the ways teachers evaluate the content are determined by what they believe about the nature of mathematics, mathematics learning, and mathematics teaching. So investigating possible correlations between the beliefs about the nature of mathematics and the beliefs about the teaching of mathematics becomes important.

The second hypothesis of the fifth sub-problem ($H_0$5.2) is: "There is no statistically significant relationship between the belief that mathematics has no effect on cognitive development (BaNoM 1) and the belief that it is not teachers' responsibility to provide the students understand mathematics (BaToM 2)."

After testing the hypothesis 5.2, it is found that BaToM 2, which is the belief about the teacher's responsibility of providing students understand mathematics, is correlated significantly with BaNoM 1 ($r = 0.314$, $p < 0.05$). This was an expected correlation because if an individual believes that mathematics has no effect on cognitive development then it is not teacher's responsibility to provide a student

understand mathematics. What is interesting here is the fact that approximately ten percent of prospective math teachers do not believe in the effect of mathematics on cognitive development. This item was a negative item and it might be misunderstood but if this was not the case, an important problem can be said to exist.

Table 4.5 Frequencies and Percentages for BaNoM 1 and BaToM 2

Items	Agree	Undecided	Disagree
BaNoM 1	9 (11.4 %)	0 (0 %)	70 (88.6 %)
BaToM 2	6 (7.6 %)	11 (13.9 %)	62 (78.5 %)

Table 4.5 shows that around eighty percent of preservice math teachers at the METU and the Gazi University believe that mathematics has an effect on cognitive development, whereas again approximately eighty percent believe that it is the teacher's responsibility to make students understand mathematics.

The 9^{th} and 11^{th} items in BaToM were also expected to have significant relationship with BaNoM 1 since the first is the belief that teacher should endeavor to develop the students' mathematical ability and the second is the belief that importance should be given to teaching mathematical way of thinking. But no statistically significant relationships could be found.

The third hypothesis of the fifth sub-problem ($H_0$5.3) was" ***There*** is no statistically significant relationship between the belief that mathematics is a language

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

(BaNoM 2) and the belief that usage of analogies, metaphors, and symbolic expressions should be encouraged (BaToM 28)".

After the testing of the hypothesis 5.3, it is found that there exists no statistically significant relationship between BaNoM 2 and BaToM 28 ($r = 0.069$, $p > 0.05$). A relationship was expected here because analogies, metaphors, and symbolic expressions are like the skeleton of a language. Perhaps the subjects misunderstood 28th item of BaToM since the concepts included like, "metaphors", and "analogies", were not very common concepts.

The fourth hypothesis of the fifth sub-problem ($H_0$5.4) is: "There is no statistically significant relationship between the belief that mathematics is a language (BaNoM 2) and the belief that efforts should be made in order to help students acquire the ability to make connections between other fields and mathematics (BaToM 6)."

After testing the hypothesis it is found that a statistically significant relation exists between BaNoM 2and BaToM 6($r = 0.238$, $p < 0.05$). A language is something that is used to communicate and establish relationships. A language also provides a common base for its users to produce ideas on. So if mathematics is a language then students should understand that it provides a common base (a common language) for any other science fields and be able to establish the connection. Frequencies and percentages for BaNoM 2 and BaToM 6 are given in Table 4.6:

Table 4.6 Frequencies and Percentages for BaNoM 2 and BaToM 6

Items	Agree	Undecided	Disagree
BaNoM 2	3 (3.8 %)	12 (15.2 %)	64 (81.0 %)
BaToM 6	1 (1.3 %)	2 (2.5 %)	76 (96.2 %)

As seen from the Table 4.6, most of the subjects disagreed with BaNoM 2 and BaToM 6.

$7^{th,}$ 20^{th}, and 28^{th} items in BaToM are directly related to the belief that mathematics is a language but there cannot be found statistically relationship between BaNoM 2 and these items. Seventh item of BaToM was "students should be acquired some abilities to make connections between daily language and the language of mathematics". There is no statistically significant relationship between BaNoM 2 and BaToM 7 ($r=0.001$, $p>0.05$). Twentieth item of BaToM was "there is no need for students to express their ideas with the language of mathematics". There is no statistically significant relationship between BaNoM 2 and BaToM 20 ($r=0.098$, $p>0.05$). Twenty eighth item of BaToM was "The usage of metaphors, analogies, simulations and symbolic representations should be encouraged". There is no statistically significant relationship between BaNoM 2 and BaToM 28 ($r=0.069$, $p>0.05$).

The fifth hypothesis of the fifth sub-problem ($H_0 5.5$) is: "There is no statistically significant relationship between the belief that mathematics is a subject

that concerns everybody (BaNoM 3), and the belief that students should be explained why mathematics is taught (BaToM 1).

After the testing of the hypothesis it is found that there exists a statistically significant relation between BaNoM3 and BaToM1 ($r = 0.287$, $p<0.05$). Frequencies and percentages for BaNoM 3 and BaToM 1 are as follows:

Table 4.7 Frequencies and Percentages for BaNoM 3 and BaToM 1

Items	Agree	Undecided	Disagree
BaNoM 3	7 (8.9 %)	17 (21.5 %)	55 (69.6 %)
BaToM 1	0 (0 %)	4 (5.1 %)	75 (94.9 %)

As seen from the Table 4.7, approximately 95 percent of the subjects disagreed with BaToM 1 whereas 70 percent of them disagreed with BaNoM 3. If mathematics is not a matter of concern for everybody then there is no need to explain why it is taught. In fact, if it is so, a valid reason does not even exist. If a teacher believes that explaining why mathematics is taught is a necessity then he or she can believe that there exists a valid reason for everybody to deal with mathematics.

The sixth hypothesis of the fifth sub-problem ($H_0 5.6$) is: There is no statistically significant relationship between the belief that mathematics is a science that explains natural events using numbers (BaNoM 4), and the belief that students should be explained why mathematics is taught (BaToM 1).

After testing the hypothesis 5.6, it is found that there exists statistically significant relation between BaNoM 4 and BaToM 11 ($r = 0.276$, $p < 0.05$). Frequencies and percentages for BaNoM 4 and BaToM 1 are given in Table 4.8:

Table 4.8 Frequencies and Percentages for BaNoM 4 and BaToM 1

Items	Agree	Undecided	Disagree
BaNoM 4	8 (10.1 %)	27 (34.2 %)	44 (55.7 %)
BaToM 1	0 (0 %)	4 (5.1 %)	75 (94.9 %)

Table 4.8 shows that fifty five percent of the subjects disagreed with BaNoM 4 which is "Mathematics is a science that explains natural events using numbers." This item itself is a reason for teaching mathematics. If one wants to understand what is going on around (natural events), if one thinks that nature needs explanation, then he will absolutely believe that mathematics, as a perfect tool, should be taught and the reason for this process should be explained to students. His or her belief in this direction will show how consistent his or her belief system is.

The seventh hypothesis of the fifth sub-problem ($H_0$5.7) is: "There is no statistically significant relationship between the belief that mathematics is a science that explains natural events using numbers (BaNoM 4), and the belief that usage of analogies, metaphors, and symbolic expressions should be encouraged (BaToM 28)."

After testing the hypothesis 5.7, it is found that there exists statistically significant relation between BaNoM 4 and BaToM 28 ($r = -0.232$, $p < 0.05$). Frequencies and percentages for BaNoM 4 and BaToM 28 are given in Table 4.9:

Table 4.9 Frequencies and Percentages for BaNoM 4 and BaToM 28

Items	Agree	Undecided	Disagree
BaNoM 4	8 (10.1 %)	27 (34.2 %)	44 (55.7 %)
BaToM 28	6 (7.6 %)	29 (36.7 %)	43 (54.4 %)

As seen in Table 4.9 36.7 percent of the subjects are undecided whereas 54.4 percent of then disagreed BaToM 28, which was, "Usage of analogies, metaphors, and symbolic expressions should be encouraged." The relationship between this item and 4th item of BaNoM can be summarized as follows. Symbolic expressions, metaphors, and analogies are all mediums for the translation between the real life and virtual world of mathematics. To explain the nature using numbers one needs to translate the real world into numbers by means of these media.

The eighth hypothesis of the fifth sub-problem ($H_0$5.8) is: "There is no statistically significant relationship between the belief that mathematics helps people develop their problem solving abilities (BaNoM 5), and the belief that students should be helped to acquire problem-solving skills using various strategies (BaToM 8)."

After testing the hypothesis 5.8 it is found that there exists a statistically significant relationship between BaNoM 5 and BaToM 8 ($r = 0.241$, $p < 0.05$). The frequency and percentages for all these items are given below.

Table 4.10 Frequencies and Percentages for BaNoM 5, BaToM 8

Items	Agree	Undecided	Disagree
BaNoM 5	1 (1.3 %)	4 (5.1 %)	73 (92.4 %)
BaToM 8	0 (0 %)	2 (2.5 %)	76 (96.2 %)

As seen from Table 4.10 the percentage of subjects who disagree with both of BaNoM 5 and BaToM 8 is above ninety. If a teacher candidate believes that mathematics improves problem-solving ability, he/she may also believe in necessity of working on students problem-solving abilities.

The ninth hypothesis of the fifth sub-problem ($H_0 5.9$) is: "There is no statistically significant relationship between the belief that mathematics helps people develop their problem solving abilities (BaNoM 5), and the belief that importance should be given to problem solving methods including understanding the problem, making a plan, carry out a plan and check (BaToM 13). "

A statistically significant relation was also found between BaNoM 5 and BaToM 13 ($r = 0.219$, $p < 0.05$). The frequency and percentages for all these items are given below.

Table 4.11 Frequencies and Percentages for BaNoM 5, BaToM 13

Items	Agree	Undecided	Disagree
BaNoM 5	1 (1.3 %)	4 (5.1 %)	73 (92.4 %)
BaToM 13	0 (0 %)	5 (6.3 %)	74 (93.7 %)

The values from Table 4.10 and Table 4.11 shows that percentages of subjects disagreed with BaToM 8 and BaToM 13 are very close to each other. A statistically significant relation between BaToM 8 and BaToM 13 was being expected since these items were versions of BaNoM 5 interpreted from teacher's perspective.

The tenth hypothesis of the fifth sub-problem ($H_0 5.10$) is: "There is no statistically significant relationship between the belief that mathematics is an art like poetry or music (BaNoM 6), and the belief that studies should be realized to help students acquire the ability to make connections between other fields and mathematics (BaToM 6)."

After the testing of the hypothesis it is found that there exists a statistically significant relation between BaNoM 6 and BaToM 6 ($r=0.283$, $p<0.05$). Frequencies and percentages for BaNoM 6 and BaToM 6 given below:

Table 4.12 Frequencies and Percentages for BaNoM 6 and BaToM 6

Items	Agree	Undecided	Disagree
BaNoM 6	6 (7.6 %)	22 (27.8 %)	50 (63.3 %)
BaToM 6	1 (1.3 %)	2 (2.5 %)	76 (96.2 %)

As seen in Table 4.12, the percentage of individuals, who believe that mathematics is an art, are not as high as the ones that believe that as mathematics teachers they are supposed to explain the relationships between mathematics and other fields.

The eleventh hypothesis of the fifth sub-problem ($H_0$5.11) is: "There is no statistically significant relationship between the belief that mathematics is an art like poetry or music (BaNoM 6), and the belief that the value of mathematics in society and in other fields should be taught by showing the applications of it (BaToM 25)." After the testing of the hypothesis it is found that the correlation between BaNoM 6 and BaToM 25 is statistically significant ($r=0.367$, $p<0.05$). Frequencies and percentages for BaNoM 6 and BaToM 25 are given below:

Table 4.13 Frequencies and Percentages for BaNoM 6 and BaToM 25

Items	Agree	Undecided	Disagree
BaNoM 6	6 (7.6 %)	22 (27.8 %)	50 (63.3 %)
BaToM 25	1 (1.3 %)	3 (3.8 %)	75 (94.9 %)

As seen in Table 4.13, high percentages of the subjects disagreed with both BaNoM 6 and BaToM 25. A reason for this may be that the individuals who believe that mathematics is an art, also believe that the teachers should explain the value of mathematics in society and in other fields by means of showing applications (just like artists do).

The twelfth hypothesis of the fifth sub-problem ($H_0 5.12$) is: "There is no statistically significant relationship between the belief that mathematics is an art like poetry or music (BaNoM 6), and the belief that terms and symbols proposed by students should be used besides conventional terms and symbols (BaToM 26)."

The testing of the hypothesis showed that there exists a statistically significant relation between BaNoM 6 and BaToM 26 ($r = 0.283$, $p < 0.05$). Frequencies and percentages for BaNoM 6 and BaToM 26 are given on Table 4.14:

Table 4.14 Frequencies and Percentages for BaNoM 6 and BaToM 26

Items	Agree	Undecided	Disagree
BaNoM 6	6 (7.6 %)	22 (27.8 %)	50 (63.3 %)
BaToM 26	16 (20.3 %)	22 (27.8 %)	41 (51.9 %)

It is understood from Table 4.14 that, the percentages of subjects who are undecided about BaNoM 6 and BaToM 26 are equal whereas the percentages of subjects who disagree with both BaNoM 6 and BaToM 26 are very close. This may be because of the following. Teacher candidates who think that mathematics is an art

may be interested in non-traditional methods of teaching (like an artist). In art there is no one-way of expressing feelings, to let students use their own symbols, reach the truth through their customized ways can only be tolerated by a teacher who sees mathematics as an art. If mathematics is a strict, rigid, unchanging body of information unlike art then there is no way of going beyond traditional methods.

The thirteenth hypothesis of the fifth sub-problem ($H_0$5.13) is: "There is no statistically significant relationship between the belief that mathematics is an art like poetry or music (BaNoM 6), and the belief that other methods than traditional methods should be used in mathematics classrooms (BaToM 27).

After testing the hypothesis 5.13 a statistically significant relation between the items BaNoM 6 and BaToM 27 was expected because of the common concepts they include but a statistically significant relation could not be found ($p>0.05$, $r=0.45$).

The fourteenth hypothesis of the fifth sub-problem ($H_0$5.14) is: "There is no statistically significant relationship between the belief that mathematics is a science that only deals with numbers (BaNoM 7), and the belief that it is not necessary to dwell upon problems taken from real life (BaToM 10)."

After testing the hypothesis, it is found that a statistically significant relation between BaNoM 7 and BaToM 10 exists ($r=0.357$, $p<0.05$). Frequency and percentages for BaNoM 7 and BaToM 10 are given on Table 4.15:

Table 4.15 Frequencies and Percentages for BaNoM 7 and BaToM 10

Items	Agree	Undecided	Disagree
BaNoM 7	2 (2.5 %)	8 (10.1 %)	68 (98.7 %)
BaToM 10	4 (5.1 %)	8 (10.1 %)	67 (84.8 %)

It seems from Table 4.15 that the percentages of the subjects that disagree with BaNoM 7 and BaToM 10 are almost equal. A possible explanation for the correlation between them may be as follows: If a prospective teacher believes that mathematics deals only with numbers and has nothing to do with things other numbers then he or she may believe that there is no need to dwell upon the solution of "real-life" problems. If numbers are all he or she needs, if everything is virtual, if everything begins and ends in his or her mind, then there is no need to go out.

The fifteenth hypothesis of the fifth sub-problem ($H_0$5.15) is: "There is no statistically significant relationship between the belief that mathematics is a way of thinking that human beings develop when they solve the problems they face in real life (BaNoM 8), and the belief that students should be helped to acquire problem-solving skills using various strategies (BaToM 8)."

Testing of the hypothesis 5.15 showed that there is no statistically significant relation between BaNoM 8 and BaToM 8 ($r=0.175$, $p>0.05$). The results of Pearson correlation on BaNoM 8 and BaToM 8 can be found in Table 4.16.

Table 4.16 Results of Pearson Correlation between BaNoM 8 and BaToM 8, 10, 13 and 17

		BaToM 8	BaToM 10	BaToM 13	BaToM 17
BaNoM 8	r	0.089	0.114	0.213	-0.152
	p	0.439	0.320	0.061	0.185

The sixteenth hypothesis of the fifth sub-problem ($H_0$5.16) is: "There is no statistically significant relationship between the belief that mathematics is a way of thinking that human beings develop when they solve the problems they face in real life (BaNoM 8), and the belief that it is not necessary to dwell upon problems taken from real life (BaToM 10)."

Testing of the hypothesis 5.16 showed that there is not a statistically significant relation between BaNoM 8 and BaToM 10 ($r=0.189$, $p>0.05$). The results of Pearson correlation on BaNoM 8 and BaToM 10 can be found in Table 4.16.

The seventeenth hypothesis of the fifth sub-problem ($H_0$5.17) is: "There is no statistically significant relationship between the belief that mathematics is a way of thinking that human beings develop when they solve the problems they face in real life (BaNoM 8), and the belief that importance should be given to problem solving methods including understanding the problem, making a plan, carry out a plan and check (BaToM 13)."

Testing of the hypothesis 5.17 showed that there is no statistically significant relation between BaNoM 8 and BaToM 13 ($r=0.06$, $p>0.05$). The results of Pearson correlation on BaNoM 8 and BaToM 13 can be found in Table 4.16.

The eighteenth hypothesis of the fifth sub-problem ($H_0$5.18) is: "There is no statistically significant relationship between the belief that mathematics is a way of thinking that human beings develop when they solve the problems they face in real life (BaNoM 8), and the belief that real life examples cannot be found in most subjects of the mathematics (BaToM 17)."

Testing of the hypothesis 5.18 showed that there is no statistically significant relation between BaNoM 8 and BaToM 17 ($r=0.197$, $p>0.05$). The results of Pearson correlation on BaNoM 8 and BaToM 17 can be found in Table 4.16.

The nineteenth hypothesis of the fifth sub-problem ($H_0$5.19) is: "There is no statistically significant relationship between the belief that mathematics is a way of thinking that human beings develop when they solve the problems they face in real life (BaNoM 8), and the belief that mathematics teacher should explain the historical development process of the subject (BaToM 18)."

Like preceding one, no statistically significant relationship cannot be found for this hypothesis ($r=0.355$, $p>0.05$). Prospective teachers, who believe that mathematics is a way of thinking that human beings develop when they solve the problems they face in real life, seem not to believe in the necessity of explaining the historical development process of the subject they are teaching.

The twentieth hypothesis of the fifth sub-problem ($H_0$5.20) is: "There is no statistically significant relationship between the belief that mathematics is not a need for society (BaNoM 9), and the belief that ways of thinking mathematically should be taught (BaToM 11)."

After testing the hypothesis 5.20 it was found that, there exists a statistically significant relation between BaNoM 9 and BaToM 11 ($r=0.370$, $p<0.05$). The frequencies and percentages for BaNoM 9 and BaToM 11 are given on Table 4.17:

Table 4.17 Frequencies and Percentages for BaNoM 9 and BaToM 11

Items	Agree	Undecided	Disagree
BaNoM 9	1 (1.3 %)	4 (5.1 %)	73 (92.4 %)
BaToM 11	0 (0 %)	1 (1.3 %)	78 (98.7 %)

As seen from Table 4.17, percentages of subjects disagreed with BaNoM 9 and BaToM 11 are very close. A reason for the relation between them may be as follows: Teacher candidates believe that, mathematical ways of thinking should be taught to students, if they also believe that mathematics is a need, a necessity for society. Here by the words "need for society" the thing meant is not arithmetic. If arithmetic is the sole need of society there is no need to go further in mathematics classrooms. Four operations would be just enough for all people then. If that were the case, teaching the mathematical ways of thinking would become meaningless.

The twenty first hypothesis of the fifth sub-problem ($H_0$5.21) is: "There is no statistically significant relationship between the belief that mathematics makes life easier (BaNoM 10), and the belief that students should be acquired the skills of problem-solving using different strategies (BaToM 8)."

After testing the hypothesis it was found that, there exists a statistically significant relation between BaNoM 10 BaToM 8 ($r = 0.267$, $p < 0.05$). Frequencies and percentages for BaNoM 10 and BaToM 8 are given on Table 4.18:

Table 4.18 Frequencies and Percentages for BaNoM 10 and BaToM 8

Items	Agree	Undecided	Disagree
BaNoM 10	2 (2.5 %)	13 (16.5 %)	63 (79.5 %)
BaToM 8	0 (0 %)	1 (1.3 %)	78 (98.7 %)

A significant correlation between BaNoM 10 and BaToM 8 was an expected correlation. The possible reason for this correlation may be as follows: If mathematics makes life easy then this means that it helps solving problems faced in real life. From another perspective, if a teacher believes that mathematics makes life easier then he/she will obviously want to show this fact to his/her students. The best way of doing this is employing problem solving strategies on real life problems.

The twenty-second hypothesis of the fifth sub-problem ($H_0 5.22$) is: "There is no statistically significant relationship between the belief that mathematics makes life easier (BaNoM 10), and the belief that importance should be given to problem solving methods including understanding the problem, making a plan, carry out a plan and check (BaToM 13)."

After testing the hypothesis it was found that there exists a statistically significant relationship. The statistical values for the correlation between BaNoM 10 and BaToM 13 showed a statistically significant relation ($r = 0.264$, $p < 0.05$). Frequencies and percentages for BaNoM 10 and BaToM 13 are given on Table 4.19:

Table 4.19 Frequencies and Percentages for BaNoM 10 and BaToM 13

Items	Agree	Undecided	Disagree
BaNoM 10	2 (2.5 %)	13 (16.5 %)	63 (79.5 %)
BaToM 13	0 (0 %)	5 (6.3 %)	74 (93.7 %)

As seen from the table 79.5 percent of the subjects disagreed with BaNoM 10 whereas 93.7 percent of them disagreed with BaToM 13. The correlation, like the preceding one, shows the internal consistency of belief systems. Solving the problems makes life easier. So a mathematics teacher who believes that mathematics makes life easy, may emphasize on the problem solving strategies to teach his or her students to make life easier.

The twenty-third hypothesis of the fifth sub-problem ($H_0$5.23) is: "There is no statistically significant relationship between the belief that mathematics makes life easier (BaNoM 10), and the belief that the shortcuts and practical methods, which are used to find the solution quickly, should not be taught (BaToM 30)."

T.C. YÜKSEKÖĞRETİM KURULU
DOKÜMANTASYON MERKEZİ

After testing the hypothesis 5.23 it was found that, there is no statistically significant relation between BaNoM 10 and BaToM 30 ($r = 0.099$, $p > 0.05$). Frequencies and percentages for BaNoM 10 and BaToM 30 are given in Table 4.20:

Table 4.20 Frequencies and Percentages for BaNoM 10, and BaToM 30

Items	Agree	Undecided	Disagree
BaNoM 10	2 (2.5 %)	13 (16.5 %)	63 (79.5 %)
BaToM 30	6 (7.6 %)	25 (31.6 %)	48 (60.8 %)

As seen from Table 4.20, 31.6 percent of the subjects are undecided about BaToM 30 and much more of them (79.5%) disagree with BaNoM 10. As clever creatures, human beings run into situations that they have to do some calculations in their lives. There are some fast calculation methods in mathematics and if a teacher thinks that mathematics makes life easier he/she will want to show this by teaching these methods. A reason for not finding a statistically significant relation here may be that some of the subjects did not look from this perspective or they did not see these practical methods as the part of mathematics that makes life easier.

The twenty-fourth hypothesis of the fifth sub-problem ($H_0$5.24) is: "There is no statistically significant relationship between the belief that mathematics is a tool used for the development of the civilization (BaNoM 11), and the belief that, teacher should strive for changing the students' point of view about mathematics in a positive direction (BaToM 11)."

After testing the hypothesis it was found that there is a statistically significant relation between BaNoM 11 and BaToM 11 ($r=0.233$, $p<0.05$). The frequencies and percentages are given in Table 4.21:

Table 4.21 Frequencies and Percentages for BaNoM 11 and BaToM 11

Items	Agree	Undecided	Disagree
BaNoM 11	2 (2.5 %)	8 (10.1 %)	68 (86.1 %)
BaToM 11	0 (0 %)	1 (1.3 %)	78 (98.7 %)

Table 4.18 shows that approximately 86 percent of the subjects disagree with BaNoM 13, whereas almost all of them (98.7 %) disagree with BaToM 12 and these values produce a statistically significant relation. This correlation shows the internal consistency of the belief systems for this belief. If one believes that mathematics is a tool for the improvement of civilization then, in the name of consistency, he/she is expected to believe in striving for changing the students' point of view about mathematics in a positive direction.

The twenty-fifth hypothesis of the fifth sub-problem ($H_0 5.25$) is*:* "There is no statistically significant relationship between the belief that mathematics requires logic but not intuition (BaNoM 12), and the belief that, teacher should attach importance on guessing results (BaToM 3)."

After testing the hypothesis a statistically significant relationship cannot be found between BaNoM 12 and BaToM 3 ($r=-0.013$, $p>0.05$).

Depending on the internal consistency of the belief systems, someone who believes that mathematics requires logic but not intuition, expected to believe that letting students guess the results in mathematics is a wrong strategy. Because, guessing is an intuitive process, more than a logical process. Here, between 12^{th} item in BaNoM and 3^{rd} item in BaToM a negative correlation was expected but could not be found. Subjects might fail to realize the link between these two items or they may have failed to think the role of intuition. Perhaps the word "intuition" itself could need an explanation.

The twenty-sixth hypothesis of the fifth sub-problem ($H_0$5.26) is*:* "There is no statistically significant relationship between the belief that there is no room for creativity in mathematics (BaNoM 13), and the belief that, teacher should attach importance and listen to the students' opinions about the subject which, is being told (BaToM 19)."

After testing the hypothesis 5.26 it is found that there is no statistically significant relation between them ($r = 0.110$, $p > 0.05$).

If one believes in a role of creativity in mathematics then as a reflection of this belief on teaching process, he or she is expected to pay attention and listen to what students say about the subject taught in mathematics classroom. If not, there is no need to listen to the students because students cannot have opinions about the subject, they can only learn them. Subjects might fail to realize the link between these two items. And here, the word "creativity" required an explanation.

The twenty-seventh hypothesis of the fifth sub-problem ($H_0$5.27) is: "There is no statistically significant relationship between the belief that there is no room for creativity in mathematics (BaNoM 13), and the belief that beside the usage of conventional terms and symbols, usage of terms and symbols proposed by students should be encouraged (BaToM 26)."

After the testing of the hypothesis 5.27, it is found that, there is a statistically significant relation between BaNoM 13 and BaToM 26 ($r=0.230$, $p<0.05$). Frequencies and percentages for BaNoM 13 and BaToM 26 are given in Table 4.22:

Table 4.22 Frequencies and Percentages for BaNoM 13, and BaToM 26

Items	Agree	Undecided	Disagree
BaNoM 13	5 (6.3 %)	9 (11.4 %)	63 (79.7 %)
BaToM 26	16 (20.3 %)	22 (27.8 %)	41 (51.9 %)

As seen from table 4.22, almost eighty percent of the subjects disagreed with BaNoM 13 whereas 52 percent of them disagreed with BaToM 26. A statistically significant relation was found between BaNoM 13 and BaToM 26. This was an expected correlation because teachers who believe in a significant role of creativity in mathematics also encourage creative proposals of their students. If a teacher refuses and discourages the proposals of students, he or she cannot be said to believe in a role of creativity in mathematics.

The twenty-eighth hypothesis of the fifth sub-problem ($H_0$5.28) is: "There is no statistically significant relationship between the belief that mathematics help people acquire logical thinking ability (BaNoM 14), and the belief that importance should be attached to teaching of mathematical way of thinking (BaToM 11)."

Testing of this hypothesis 5.28 showed that there is a statistically significant relation between them ($r = 0.225$, $p < 0.05$). Frequencies and percentages for BaNoM 14 and BaToM 11 are given in Table 4.20:

Table 4.23 Frequencies and Percentages for BaNoM 14, and BaToM 11

Items	Agree	Undecided	Disagree
BaNoM 14	1 (1.3 %)	4 (5.1 %)	72 (91.1 %)
BaToM 11	0 (0 %)	1 (1.3 %)	78 (98.7 %)

As seen in Table 4.23, more than ninety percent of the subjects disagreed with these two items. Logic (in Aristotelian sense) is something that comes from the nature of human beings and it is reflected in every language. Logical thinking is always appreciated since it provides a common base for human beings to establish a communication on. In other words logical thinking is a medium for communication. BaNoM 14 is the belief that mathematics help people to gain the ability of thinking logically. Therefore, teaching of mathematics should include the teaching mathematical ways of thinking.

The twenty-ninth hypothesis of the fifth sub-problem ($H_0$5.29) is: "There is no statistically significant relationship between the belief that mathematics is a tool that helps other branches of science develop (BaNoM 16), and the belief that studies should be realized to help students acquire the ability to make connections between other fields and mathematics (BaToM 6)."

Testing of this hypothesis 5.29 showed that there is no statistically significant relation between them ($r=-0.016$, $p>0.05$). Frequency and percentages for BaNoM 16 and BaToM 6 are given in Table 4.21 as follows:

Table 4.24 Frequencies and Percentages for BaNoM 16, and BaToM 6

Items	Agree	Undecided	Disagree
BaNoM 16	4 (5.1 %)	9 (11.4 %)	65 (82.3 %)
BaToM 6	1 (1.3 %)	2 (2.5 %)	76 (96.2 %)

As seen from Table 4.24 more than eighty percent of the subjects disagreed with both of BaNoM 16 and BaToM 6. It is thought that if mathematics is considered as a tool, which is used for developing other branches of science, then the improvement of the ability to make connections between mathematics and other fields should be considered as important.

The frequencies and percentages of the answers to items in BaNoM and BaToM are given in Appendix C and Appendix D.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

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

5.1 Conclusions

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

1. There is a statistically significant difference between the mean scores of preservice mathematics teachers at METU and those at Gazi University in terms of beliefs about the nature of mathematics and the teaching of mathematics.
2. There is no statistically significant difference between the mean scores of girls and boys in terms of beliefs about the nature of mathematics and the teaching of mathematics.
3. There is a statistically significant relationship between beliefs of preservice mathematics teachers about the nature of mathematics and about the teaching of mathematics.

4. Preservice mathematics teachers enrolled at the mathematics education programs of the METU and the Gazi University do not have definite, clear cut beliefs about both the nature of mathematics and the teaching of mathematics. Their answers for many items were generally accumulated around the categories "tend to agree" and "tend to disagree" which were the categories that were then reduced to one category named "undecided".

There were some statistically significant relations between related items of BaNoM and BaToM found. But the number of correlated items was less than expected. These correlations showed the internal consistency of the belief systems of the subjects. For example a statistically significant relation could not be found between the belief that mathematics requires logic but not intuition (BaNoM 13) and the belief that, teacher should attach importance on guessing results (BaToM 4). Guessing results seem to be a completely intuitive process and a reflection of the belief that "mathematics requires intuition as well as logic" on the beliefs about the teaching of mathematics. A statistically significant negative correlation was expected here but could not be found. The present studies main purpose was to investigate the "surface beliefs" of preservice mathematics teachers and draw a map of these "surface beliefs". So this may or may not show the lack of internal consistency of the belief systems of the preservice teachers but surely will provide a key point for starting a research.

5.2 Recommendations

In this section, some recommendations for further research and practice on the field of beliefs of preservice mathematics teachers.

In the present study it is intended to provide an idea about the beliefs of preservice mathematics teachers or as mentioned before, a map of "surface beliefs". This subject requires more detailed research studies. First of all the sample size must be increased in further studies. To be able to talk about Turkey overall, subjects from different universities of different geographical regions should be selected. As a second issue, as mentioned in the present study before, using scales, questionnaires may provide an idea or a map of surface beliefs of subjects but for a "deep" investigation of beliefs, qualitative methods of research seem more appropriate. Case studies, interviews should be conducted and the investigation process should be laid in time. By using these techniques the research will provide more accurate information a instead of a snapshot picture of the beliefs.

In Turkey, the beliefs of preservice teachers should become a matter of concern for teacher education programs. Not only the dispositions or beliefs of preservice teachers that they brought to university but also why they held them should be investigated. As also suggested by Raymond and Santos (1995) prospective teachers should experience early and continuous challenges to their beliefs so that they may become more aware of relationships between classroom experiences and beliefs. In order to realize this the number of teaching practice courses should be increased.

In teacher education programs, students (or prospective teachers) should be guided to construct a consistent belief system or at least modify their systems of beliefs to make them more consistent. The reasons for being a teacher and for teaching mathematics should be made clear in the minds of prospective teachers.

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APPENDICES

APPENDIX A

MATEMATİKLE İLE İLGİLİ İNANÇLAR

(BaNoM)

	Kesinlikle Katılıyorum	Katılıyorum	Katılabilirim	Katılmayabilirim	Katılmıyorum	Kesinlikle Katılmıyorum
1) Matematiğin, zihinsel gelişmeye etkisi yoktur.	O	O	O	O	O	O
2) Matematik bir dildir.	O	O	O	O	O	O
3) Matematik her insan için ilgilenmeye değer bir konudur.	O	O	O	O	O	O
4) Matematik, doğal olayları sayılarla açıklayan bir bilimdir.	O	O	O	O	O	O
5) Matematik, problem çözme becerisini geliştirir.	O	O	O	O	O	O
6) Matematik, resim, şiir ve müzik gibi bir sanattır.	O	O	O	O	O	O
7) Matematik, sayılarla uğraşan bir bilimdir.	O	O	O	O	O	O
8) Matematik, insanların hayatta karşılaştıkları problemleri çözerken geliştirdikleri bir düşünme biçimidir.	O	O	O	O	O	O
9) Matematik toplum için bir ihtiyaç değildir.	O	O	O	O	O	O
10) Matematik hayatı kolaylaştırır.	O	O	O	O	O	O
11) Matematik, uygarlığın gelişimi için kullanılan bir araç değildir.	O	O	O	O	O	O

	Kesinlikle Katılıyorum	Katılıyorum	Katılabilirim	Katılmayabilirim	Katılmıyorum	Kesinlikle Katılmıyorum
12) Matematik için sezgi değil mantık gerekir.	O	O	O	O	O	O
13) Matematikte yaratıcılığın yeri yoktur.	O	O	O	O	O	O
14) Matematik, mantıksal düşünmenin kazandırılmasında yardımcı olur.	O	O	O	O	O	O
15) Matematik bir oyundur.	O	O	O	O	O	O
16) Matematik diğer bilim dallarının gelişmesine katkıda bulunan bir araçtır.	O	O	O	O	O	O

APPENDIX B

MATEMATİK ÖĞRETİMİ İLE İLGİLİ İNANÇLAR (BaToM)	Kesinlikle Katılıyorum	Katılıyorum	Katılabilirim	Katılmayabilirim	Katılmıyorum	Kesinlikle Katılmıyorum
1) Öğrencilere, matematiğin neden öğretildiği açıklanmalıdır.	O	O	O	O	O	O
2) Öğrencinin matematiği anlamasını sağlamak öğretmenin sorumluluğu değildir.	O	O	O	O	O	O
3) Öğretmen, sonucun tahmin edilmesine önem vermelidir.	O	O	O	O	O	O
4) Öğrencilere, matematik konuları arasındaki ilişkileri ifade edebilme becerileri kazandırmaya çalışılmalıdır.	O	O	O	O	O	O
5) Öğrencilere, tamamlanan çözümün sağlamasını yapma becerileri kazandırmak gereksizdir.	O	O	O	O	O	O
6) Öğrencilere, matematik ve diğer alanlar arasında bağlantı kurabilme becerileri kazandırmaya çalışılmalıdır.	O	O	O	O	O	O
7) Öğrencilere, günlük yaşamdaki dil ile matematiksel dil arasında ilişki kurabilme becerileri kazandırmaya gerek yoktur.	O	O	O	O	O	O
8) Öğrencilere, farklı stratejiler kullanarak problem çözme becerileri kazandırılmaya çalışılmalıdır.	O	O	O	O	O	O

	Kesinlikle Katılıyorum	Katılıyorum	Katılabilirim	Katılmayabilirim	Katılmıyorum	Kesinlikle Katılmıyorum
9) Öğrencinin matematiksel kabiliyetlerinin geliştirilmesine çalışılmalıdır.	O	O	O	O	O	O
10) Gerçek hayattan alınan problemlerin çözülmesi üzerinde fazla durulmamalıdır.	O	O	O	O	O	O
11) Matematiksel düşünce şeklinin öğretilmesine önem verilmelidir	O	O	O	O	O	O
12) Öğrencilerin matematiğe bakış açılarını olumlu yönde değiştirmek için çaba harcanmalıdır.	O	O	O	O	O	O
13) Problemi anlama, plan kurma, planı uygulama ve kontrol etme aşamalarını içeren "problem çözme" yöntemine önem verilmelidir.	O	O	O	O	O	O
14) Matematiğin bir çok konusu keşfetme yöntemiyle öğretilmeye elverişsizdir.	O	O	O	O	O	O
15) Matematik öğretiminde kavram ve kuralların ezberlenmesine ağırlık verilmelidir.	O	O	O	O	O	O
16) Öğrencinin, matematik konusunda kendine güveni arttırılmalıdır.	O	O	O	O	O	O
17) Matematiğin çoğu konusunda gerçek hayattan örnekler bulunamaz.	O	O	O	O	O	O
18) Matematik öğretmeni, anlattığı konunun tarih içindeki gelişim sürecinden de bahsetmelidir.	O	O	O	O	O	O
19) Matematik öğretmeninin, öğrencilerin konuyla ilgili fikirlerine değer verip, bunları dinlemesi gerekir.	O	O	O	O	O	O

	Kesinlikle Katılıyorum	Katılıyorum	Katılabilirim	Katılmayabilirim	Katılmıyorum	Kesinlikle Katılmıyorum
20) Sınıfta, öğrencilerin fikirlerini matematiksel dille ifade etmelerine gerek yoktur.	O	O	O	O	O	O
21) Matematik dersinde öğrencilerin, sınıfta çözülen problemlerden, yeni problemler üretebilecek duruma gelmeleri gerekir.	O	O	O	O	O	O
22) Matematik öğretiminde hesap makinalarının kullanımına izin verilmemelidir.	O	O	O	O	O	O
23) Öğrenciler birlikte çalışırlarsa matematiği daha iyi anlarlar.	O	O	O	O	O	O
24) Matematiğin daha iyi anlaşılabilmesi için somut materyaller, grafikler ve tablolar kullanılmalıdır.	O	O	O	O	O	O
25) Matematiğin toplumdaki ve diğer alanlardaki değeri, uygulama alanları gösterilerek öğretilmelidir.	O	O	O	O	O	O
26) Geleneksel terim ve sembollerin yanında, öğrencilerce önerilen terim ve sembollerin kullanımı teşvik edilmelidir.	O	O	O	O	O	O
27) Geleneksel öğretim yöntemlerinden farklı öğretim yöntemleri kullanılmalıdır.	O	O	O	O	O	O
28) Metaforların, analojilerin, benzetmelerin yani sembolik anlatımların kullanımı teşvik edilmelidir.	O	O	O	O	O	O
29) Matematik öğretiminde bilgisayarlardan faydalanılmalıdır.	O	O	O	O	O	O
30) Sorular ve problemler çözülürken cevabı çabucak bulmaya yarayan kısa ve pratik yollar öğretilmemelidir.	O	O	O	O	O	O

	Kesinlikle Katılıyorum	Katılıyorum	Katılabilirim	Katılmayabilirim	Katılmıyorum	Kesinlikle Katılmıyorum
31) Matematik öğretiminde alıştırma ve tekrarlara ağırlık verilmelidir.	O	O	O	O	O	O
32) Matematik öğretiminde "tepegözlerden" faydalanılmalıdır.	O	O	O	O	O	O
33) Matematik en iyi klasik ders anlatımı yöntemiyle öğretilir.	O	O	O	O	O	O
34) Matematik öğretiminde tartışma yöntemi kullanılmamalıdır.	O	O	O	O	O	O

APPENDIX C

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

Item	Agree	Undecided	Disagree
BaNoM 1	9 (11.4 %)	0 (0 %)	70 (88.6)
BaNoM 2	3 (3.8 %)	12 (15.2 %)	64 (81.0 %)
BaNoM 3	7 (8.9 %)	17 (21.5 %)	55 (69.6 %)
BaNoM 4	8 (10.1 %)	27 (34.2 %)	44 (55.7 %)
BaNoM 5	1 (1.3 %)	4 (5.1)	73 (92.4 %)
BaNoM 6	6 (7.6 %)	22 (27.8 %)	50 (63.3 %)
BaNoM 7	2 (2.5 %)	8 (10.1 %)	68 (86.1 %)
BaNoM 8	3 (3.8 %)	16 (20.3 %)	59 (74.7 %)
BaNoM 9	1 (1.3 %)	4 (5.1 %)	73 (92.4 %)
BaNoM 10	2 (2.5 %)	13 (16.5 %)	63 (79.7 %)
BaNoM 11	2 (2.5 %)	8 (10.1 %)	68 (86.1 %)
BaNoM 12	32 (40.5 %)	26 (32.9 %)	20 (25.3 %)
BaNoM 13	5 (6.3 %)	9 (11.4 %)	63 (79.7 %)
BaNoM 14	1 (1.3 %)	4 (5.1 %)	72 (91.1 %)
BaNoM 15	15 (19 %)	30 (38 %)	33 (41.8 %)
BaNoM 16	4 (5.1 %)	9 (11.4 %)	65 (82.3 %)

APPENDIX D

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

Item	Agree	Undecided	Disagree
BaToM 1	0 (0 %)	4 (5.1 %)	75 (94.9)
BaToM 2	6 (7.6 %)	11 (13.9 %)	62 (78.5 %)
BaToM 3	19 (24.1 %)	27 (34.2 %)	32 (40.5 %)
BaToM 4	0 (0 %)	1 (1.3 %)	78 (98.7 %)
BaToM 5	4 (5.1 %)	11 (13.9)	64 (81.0 %)
BaToM 6	1 (1.3 %)	2 (2.5 %)	76 (96.2 %)
BaToM 7	4 (5.1 %)	9 (11.4 %)	66 (83.5 %)
BaToM 8	0 (0 %)	2 (2.5 %)	76 (96.2 %)
BaToM 9	0 (0 %)	2 (2.5 %)	76 (96.2 %)
BaToM 10	4 (5.1 %)	8 (10.1 %)	67 (84.8 %)
BaToM 11	0 (0 %)	1 (1.3 %)	78 (98.7 %)
BaToM 12	0 (0 %)	3 (3.8 %)	76 (96.2 %)
BaToM 13	0 (0 %)	5 (6.3 %)	74 (93.7 %)
BaToM 14	7 (8.9 %)	22 (27.8 %)	50 (63.3 %)
BaToM 15	3 (3.8 %)	13 (16.5 %)	63 (79.7 %)
BaToM 16	0 (0 %)	2 (2.5 %)	77 (97.5 %)

Table D.1 (continued)

Item	Agree	Undecided	Disagree
BaToM 17	50 (63.3 %)	19 (24.1 %)	10 (12.7 %)
BaToM 18	5 (6.3 %)	15 (19.0 %)	59 (74.7 %)
BaToM 19	1 (1.3 %)	5 (6.3 %)	73 (92.4 %)
BaToM 20	7 (8.9 %)	24 (30.4 %)	48 (60.8 %)
BaToM 21	0 (0 %)	12 (15.2)	66 (83.5 %)
BaToM 22	19 (24.1 %)	22 (27.8 %)	37 (46.8 %)
BaToM 23	0 (0 %)	26 (32.9 %)	52 (65.8 %)
BaToM 24	0 (0 %)	5 (6.3 %)	73 (92.4 %)
BaToM 25	1 (1.3 %)	3 (3.8 %)	75 (94.9 %)
BaToM 26	16 (20.3 %)	22 (27.8 %)	41 (51.9 %)
BaToM 27	1 (1.3 %)	10 (12.7 %)	67 (84.8 %)
BaToM 28	6 (7.6 %)	29 (36.7 %)	43 (54.4 %)
BaToM 29	1 (1.3 %)	18 (22.8 %)	60 (75.9 %)
BaToM 30	6 (7.6 %)	25 (31.6 %)	48 (60.8 %)
BaToM 31	66 (83.5 %)	12 (15.2 %)	1 (1.3 %)
BaToM 32	8 (10.1 %)	27 (34.2 %)	43 (54.4 %)
BaToM 33	1 (1.3 %)	22 (27.8 %)	56 (70.9 %)
BaToM 34	5 (6.3 %)	9 (11.4 %)	65 (82.3 %)

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