CONSTRUCTION OF A MATHEMATICS RELATED BELIEF SCALE FOR ELEMENTARY PRESERVICE MATHEMATICS TEACHERS

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ABSTRACT

CONSTRUCTION OF A MATHEMATICS RELATED BELIEF SCALE FOR ELEMENTARY PRESERVICE MATHEMATICS TEACHERS

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The purpose of this study is to construct a valid and reliable mathematics related beliefs scale for determining preservice elementary mathematics teachers' mathematics related beliefs in Turkey and investigating the impact of the gender and year level on the preservice mathematics teachers' mathematics related beliefs. For the first purpose, the "Mathematics Related Belief Scale (MRBS)" was developed based on the combination of the belief frameworks in the literature. Data were collected from ten different universities from Ankara, Balıkesir, Burdur, Bolu, Gaziantep, İzmir, Van, and Samsun in the spring semester of 2009-2010 academic year. A total of 584 third and fourth year preservice mathematics teachers participated in this study. Data were analyzed by descriptive and inferential statistics.

The results showed that MRBS was a valid and reliable scale which measured Turkish preservice teachers' mathematics related beliefs. MRBS had two components "constructivist beliefs" and "traditional beliefs" of mathematics and teaching mathematics. There was a significant effect of gender on preservice teachers' mathematics related beliefs. No significant difference in preservice teachers' mathematics related beliefs was detected in terms of year level in the teacher education program. The MRBS could be used for investigating preservice teachers' mathematics related beliefs in order to determine effective teacher education program experiences.

Keywords: Preservice Mathematics Teachers, Mathematics Related Beliefs, Scale Development, Gender, Year Level

ÖZ

İLKÖĞRETİM MATEMATİK ÖĞRETMEN ADAYLARI İÇİN MATEMATİK HAKKINDAKİ İNANIŞLAR ÖLÇEĞİ GELİŞTİRME

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Bu çalışmanın amacı, Türkiye'deki ilköğretim matematik öğretmeni adaylarının matematik hakkındaki inanışlarını belirlemek için geçerli ve güvenilir "Matematik Hakkındaki İnanışlar Ölçeği (MHİÖ)" geliştirmek ve cinsiyetin ve sınıf düzeyinin ilköğretim matematik öğretmeni adaylarının matematik hakkındaki inanışları üzerindeki etkisini incelemektir. Bu amaçla, alanyazındaki inanış modellerinin birleştirilmesi ile Matematik Hakkındaki İnanışlar Ölçeği oluşturulmuştur. Veriler Ankara, Balıkesir, Burdur, Bolu, Gaziantep, İzmir, Van ve Samsun illerindeki on değişik üniversiteden 2009-2010 akademik yılının bahar döneminde toplanmıştır. Toplam 584 üçüncü ve dördüncü sınıf öğretmen adayı bu çalışmaya katılmıştır. Veriler, betimsel ve çıkarımsal istatistiksel yöntemleri aracılığıyla analiz edilmiştir.

Sonuçlar, MHİÖ'nin Türkiye'deki ilköğretim matematik öğretmeni adaylarının matematik hakkındaki inanışlarını ölçmek için geçerli ve güvenilir bir ölçek olduğunu göstermektedir. MHİÖ'nin "geleneksel inanışlar" ve "yapılandırmacı inanışlar" olmak üzere iki bileşeni ortaya çıkmıştır. Ayrıca, sonuçlar cinsiyetin ilköğretim matematik öğretmeni adaylarının matematik hakkındaki inanışları üzerinde anlamlı bir etkisinin olduğunu göstermektedir. Diğer bir taraftan sonuçlar, sınıf düzeylerinin ilköğretim matematik öğretmeni adaylarının matematik hakkındaki inanışları üzerinde anlamlı bir etkisi olmadığını göstermektedir. MHİÖ öğretmen eğitimi programlarının etkililiğini arttırmak amacı ile öğretmen adaylarının matematik hakkındaki inanışlarını belirlemek için kullanılabilir.

Anahtar Kelimeler: İlköğretim Matematik Öğretmeni Adayları, Matematik Hakkındaki İnanışlar, Ölçek Geliştirme, Cinsiyet, Sınıf Düzeyi

To Tansel & Uğur KAYAN,

My mother and father

I wish I had spent more time with you

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ABBREVIATIONS

MRBS: Mathematics Related Belief Scale

MHİÖ: Matematik Hakkındaki İnanışlar Ölçeği

CGI: Cognitively Guided Instruction

MBI: Mathematics Belief Instrument

MEB: Milli Eğitim Bakanlığı

MBS: Mathematics Belief Scale

NCTM: The National Council of Teachers of Mathematics

EME: Elementary Mathematics Education

METU: Middle East Technical University

MAKÜ: Mehmet Akif Ersoy Üniversitesi

FA: Factor Analysis

KMO: Kaiser-Meyer-Olkin Measure of Sampling Adequacy

PCA: Principal Component Analysis

ANOVA: Analysis of Variance

IV(s): Independent Variables

DV: Dependent Variable

M: Mean

SD: Standard deviation

n: Sample size

p: Significance level

df: Degree of freedom

f: Frequency

CHAPTER 1

INTRODUCTION

It has become a widespread and acceptable idea that teachers' beliefs play a critical role in their teaching practice and decisions (Borko & Shavelson, 1990; Ernest, 1989; Hersh, 1986; Lindgren, 1996; Nathan & Koedinger, 2000; Raymond, 1997; Thompson, 1992). Pehkonen (2004) states that belief is situated in the cognitive and affective domains, therefore, it has components in both domains. He suggests that the belief concept should be studied deeply and carefully with its sub-domains.

Teachers organize startling, multifaceted, and ambiguous classroom environments depending on their beliefs, which are usually shaped by experiences (Haser, 2006). Teachers' beliefs should be examined to reflect their vision of good teaching and prospective teachers' beliefs are central for their teaching (Feiman & Nemser, 2001). Hence, it is important to understand teachers' beliefs in order to understand their teaching perspectives (Nespor, 1987), judgments, and perceptions in the classroom (Pajares, 1992).

Teachers' belief system is helpful in shaping their knowledge and behaviors. Their mathematics teaching approaches basically depend on their belief systems (Ernest, 1989). Thompson (1992) characterizes teachers' belief system as components of teachers' conception of mathematics. She contends that beliefs, views, and preferences affect teachers' effectiveness in the classroom.Preservice teachers have well-established beliefs they maintain from pre-college education when they start teacher education programs (Pajares, 1992). They use their beliefs to filter and organize the new knowledge (Kagan, 1992; Pajares, 1992). Research emphasizes that preservice teachers' existent characteristics, knowledge, beliefs, attitudes, experiences, and conceptions at the beginning of the teacher education program influence their development as a student and a teacher (Carter & Nodding, 1997). Kagan (1992) states that evaluation of teachers' beliefs facilitates to conceptualize teacher education programs. However, Pajares (1992) and Nespor (1987) state that teachers' beliefs are not developed through teacher education programs. Teacher education program courses do not completely change but partially affect preservice teachers' beliefs (Ambrose, 2004; Anderson & Bird, 1995; Foss & Kleinsasser, 1996; Gill, Ashton, & Algina, 2004; Joram & Gabriele, 1998).

Haser (2006) affirms that teacher education programs can be renewed after understanding the existing programs' effects on preservice teachers' beliefs. Therefore, understanding preservice teachers' mathematics related beliefs is important for organizing teacher education program courses in order to provide them with experiences that will help in developing rich and intended beliefs. She also claims that documenting preservice teachers' beliefs is helpful to show effectiveness of the teaching program.

Through these claims, it seems that investigating preservice mathematics teachers' mathematics related beliefs for Turkey can provide teacher educators with different points of view. However, prior to investigate mathematics related beliefs, the term "belief" should be well described.

In the field of education, there is no agreement on a common definition for beliefs. Pajares (1992) claims that researchers always posit new definitions for it, however, different field of studies agree that beliefs are shaped with personal experiences and transitions of culture and education (Albelson, 1979). In education, beliefs are defined as personal constructs that can provide an understanding of a teacher's practice (Nespor, 1987; Pajares, 1992; Richardson, 1996). Literature confirms that experiences shape preservice and inservice teachers' beliefs (Lampert, 1990; Pajares, 1992).

Phillipp (2007) defines the term "affect" as a combination of one's emotions, attitudes, and beliefs. He states that emotions are feelings that differentiate from cognition but easy to change, while attitudes are more cognitive than emotions but more hardly to change than emotions. Between three, Phillipp (2007) defines beliefs as the most cognitive component and the hardest one to change. He associates beliefs with the truths.

Goldin (2003) distinguishes belief structure and belief system from each other. He defines belief structure as a "set of mutually consistent, mutually reinforcing, or mutually supportive beliefs and warrants in the individual, mainly cognitive but often incorporating supportive affect" (Goldin, 2003, p.66). He claims that beliefs are special for individuals and there is not requirement that they can be shared with others, and he highlighted that individuals hold these beliefs. On the other hand, belief systems are socially and culturally shared belief structures by the others. Schoenfeld (1985) defined mathematical beliefs as personal mathematics world and one's own perspective to mathematics. Raymond (1997) described mathematical beliefs as personal decision about nature of mathematics, learning and teaching mathematics which are shaped by experience. Similarly; Sigel (1980) defined belief as experience–driven mental constructs (as cited in Pajares, 1992). This definition introduces beliefs as both personal construct and emphasizes the importance of the effects of the experiences on beliefs. Since Sigel's definition of the belief is exclusive, it is taken as the operational definition of the belief concept for this study.

There are three functions of beliefs as they play filter role, influence knowledge, and impact perceptions. Existing beliefs play filter role for new information and information is shaped according to these beliefs and experiences. They filter information and influence epistemological knowledge. Lastly, they impact behaviors of teachers and guide them (Pajares, 1992).

Depending on previous studies and different definitions of belief, mathematical belief construction seems to be basically formed by one's own experiences. Since beliefs are defined as one's truths on situations, combinations of observations and beliefs create one’s models of the world (Markovist & Schmeltzer, 2007). In other words, mathematical belief construction starts with observation and is shaped by the way one sees the world and experiences it. Enculturation and social constructs constitute beliefs (Pajares, 1992).

1.1 Theoretical Framework

Three similar teacher belief models proposed by Thompson (1992), Lindgren (1996), and Ernest (1989) are taken as a theoretical framework of this study as Thompson, Lindgren, and Ernest described and categorized the belief construct similarly. They categorized teachers’ beliefs into three levels and those levels were developed in a hierarchy, however, transitions between levels were not sharp. Although the levels in these models had some differences, they required very similar categorizations and mathematics related belief statements in these levels were close to each other. Therefore, combination of these three models provided the framework for this study.

Thompson (1992) claimed that teachers’ beliefs were formed by the combination of one’s conceptions, values, ideologies, and tendencies and these beliefs affected their instructional behaviors. She also used conceptions as beliefs because she mentioned that conceptions included beliefs. After her extensive study, she categorized beliefs in three levels as Level 0, Level 1, and Level 2. She assigned teachers who had more traditional or teacher-centered beliefs to Level 0. Teachers who hold both teacher-centered and student-centered beliefs were assigned as Level 1. Level 2 teachers were defined as teachers who had student-centered beliefs and played a guide role while teaching (Thompson, 1991).

Similar to Thompson (1991) belief model and belief levels, Lindgren (1996) developed a new belief model. She developed Thompson's model for her study and conducted both qualitative and quantitative study for this. She also categorized beliefs into three levels and named them as Rules and Routines, Discussion and Games, and Open-Approach which corresponded to Thompson's levels from the lowest to the highest. She addressed the effect of previous experiences on teachers' beliefs.

Differing from Thompson (1991), Ernest (1989) claimed that conceptions were part of beliefs and he used these two concepts interchangeably. His model provided extensive belief statements for the nature of the mathematics. He also categorized views into three levels as Instrumentalist, Platonist, and Problem-solving from poorer beliefs to richer ones.

Haser (2006) conducted a qualitative study based on the combination these frameworks to investigate preservice and inservice teachers' beliefs in Turkey and validated that the beliefs addressed in these frameworks could be observed in the Turkish case. The present study documents the construction of the Mathematics Related Belief Scale (MRBS) prepared under the light of these three belief frameworks. This study does not associate preservice teachers' beliefs with the levels of the mentioned frameworks, leaving it to be addressed in further studies.

1.2 Research Questions of the Study

The aim of this study is as follows; (a) constructing a valid and reliable mathematics related beliefs scale for determining preservice mathematics teachers' beliefs in Turkey, (b) determining Turkish preservice teachers' mathematics related beliefs, (c) investigating the impact of the gender and year level on preservice mathematics teachers' mathematics related beliefs.

For the first purpose the "Mathematics Related Belief Scale (MRBS)" was developed based on the combination of the belief frameworks in the literature. Subsequent to developing scale, the influences of gender and year level in EME program on preservice mathematics teachers' beliefs were examined. MRBS was administered to 3^{rd} and 4^{th} year level preservice teachers in 10 universities in Turkey. Validity and reliability analyses were conducted to determine whether or not MRBS was a suitable scale to investigate preservice teachers' belief differences in terms of gender and year level in EME program.

As mentioned above, there were two main purposes of this study. For investigating these purposes, the following research questions were proposed:

I. The first research question in this study is if the mathematics related beliefs scale (MRBS) is a valid and reliable scale for understanding preservice elementary mathematics teachers' mathematics related beliefs.

II. What are mathematics related beliefs of Turkish preservice mathematics teachers?

III. What is the impact of the gender and year level in EME program on preservice mathematics teachers' mathematics related beliefs?

   i. Is there a significant impact of gender on preservice elementary mathematics teachers' mathematics related beliefs?

   ii. Is there a significant impact of year level in EME program on preservice elementary mathematics teachers' mathematics related beliefs?

   iii. Is there a significant impact of gender-year level interaction on preservice elementary mathematics teachers' mathematics related beliefs?

1.3 Significance of the Study

Several studies have been conducted in Turkey since teachers' beliefs are generally considered to affect their instructional behaviors. Baydar (2000) carried out a study about importance of preservice mathematics teachers' beliefs about the nature of mathematics and teaching of mathematics in mathematics education. Baydar and Bulut (2002) stated that mathematical beliefs and how teachers' practical lives would be influenced by them should be identified to increase the quality of mathematics education. They also highlighted that researchers who would investigate mathematics classroom should also clarify the teachers' and the students' beliefs to understand the classroom environment. In addition, Kayan (2007) analyzed the types of beliefs preservice elementary mathematics teachers held about mathematical problem solving and investigated whether or not gender and university attended had any significant effect on their problem solving beliefs. Turkish preservice teachers' performance in their university coursework and mathematical self-efficacy beliefs were also analyzed (Işıksal, 2005). However, a belief scale developed to measure preservice teachers' mathematics related beliefs in Turkey which could be used in further studies seems to be missing in the accessible literature. A mathematics related belief scale based on models validated in Turkey and the literature would help further research in investigating preservice teachers' beliefs. Such a scale could also be helpful for researchers in documenting certain beliefs and relating these beliefs to other variables such as teacher education program experiences. Moreover, researchers who educate teachers could use this scale to identify their preservice teachers' beliefs. Baydar and Bulut (2002) addressed the gap in the research about when these beliefs come into play and how they become effective. Therefore, they suggested that researchers should study these issues. The mathematics related belief scale developed in this study could be used to investigate the degree of influence of beliefs and the teacher education programs year by year. Schoenfeld (1992) mentioned that “ the older measurement tools and concepts found in the affective literature are simply inadequate; they are not a level of mechanism and most often tell us that something happens without offering good suggestions as to how or why” (p. 364). Hence, the MRBS would provide the teacher educators with an up-to-date instrument in order to identify preservice teachers’ mathematics related beliefs that would help them reconsidering teacher education program experiences.

1.4 Assumptions and Limitations

For the current study, it is assumed that the volunteered preservice elementary mathematics teachers gave careful attention on the items in the MRBS. Moreover; they reflected their real beliefs and concerns about mathematics. Since the convenient sampling method was used in this study, it was also assumed that sample represented the population to a certain degree. In addition to these, developed Mathematics Related Belief Scale is assumed to measure preservice teachers’ beliefs about mathematics.

Data were collected from a limited number of Turkish universities depending on the convenient sampling model. MRBS was administered at ten different universities in eight different cities. Therefore; administration procedure of MRBS in those universities is unknown. This is a very serious limitation for this study; however, the researcher tried to keep conditions constant. For this purpose, she explained each detail of instrumentation of MRBS to graduate assistants and faculty members who helped for data collection in other universities by the phone and e-mail. By the help these detailed explanations, the researcher tried to decrease the effect of location. MRBS was implemented to preservice teachers at the end of one of their university courses. It was assumed that MRBS was administered under same conditions.

MRBS was implemented at ten universities and these universities were not selected randomly. Researcher elaborated to reach as many different universities as she could. Universities were tried to be selected from seven regions of Turkey for providing more representative sample. Yet, personal contacts were used for the administration and convenient sampling was done for this study. Therefore, generalization would be limited.

The sample of the study was formed by 3rd and 4th year preservice teachers studying at the Elementary Mathematics Education programs. Therefore, the results should be viewed carefully when compared to all mathematics teacher candidates' responses. MRBS provided only quantitative data for this study. Therefore, it is not convenient to consider - the findings as the in-depth beliefs of participants.

1.5 Definition of Important Terms

Preservice Mathematics Teacher: 3rd and 4th year undergraduate students in the Elementary Mathematics Education Program at the universities.

Beliefs: Sigel (1980) defines belief as experience–driven mental constructs (as cited in Pajares, 1992) and this definition was employed for this study.

Mathematics Related Beliefs: Beliefs about the nature of, teaching and learning mathematics, which were formed through one's experiences with mathematics while teaching and learning mathematics. It was measured by preservice teachers' mean scores in MRBS.

CHAPTER 2

LITERATURE REVIEW

The study of teachers' beliefs and their influence on instructional practice gained momentum in the last decade. Research on teachers' mental processes revealed that teachers hold well uttered educational beliefs that shape their practices (Buzeika, 1996; Frykholm, 1995; McClain, 2002; Stipek, Givvin, Salmon, & MacGyvers, 2001; Thompson, 1992). These studies had shown that each teacher had a particular belief system covering a wide range of beliefs about learners, teachers, teaching, learning, schooling, resources, knowledge, and curriculum (Gudmundsdottir & Shulman, 1987; Lovat & Smith, 1995). These beliefs act as a filter through which teachers make their decisions rather than just relying on their pedagogical knowledge or curriculum guidelines (Ambrose, 2004; Clark & Peterson, 1986).

As mentioned before, belief was defined as an experience–driven mental construct by Sigel (1980, as cited in Pajares, 1992). He emphasized that beliefs would be formed by individuals based on previous experiences. Along Sigel's definition, Green (1971) claimed that beliefs would always be formed in groups and they would always join in a belief system which was not isolated. Green described belief system with a *quasi-logical* structure where some beliefs would be derivative and some primary. One's beliefs were considered as derivative beliefs if they were derived from other beliefs.

Primary beliefs were not derived from some other beliefs and they could be the reason for other beliefs.

Green's (1971) definition of belief system and quasi-logical structure of belief system were taken as a guide by some researches. For instance, belief system was defined as "a metaphor for examining and describing how an individual's beliefs are organized" (as cited in Thompson 1992, p. 130). Thompson (1992) described three dimensions for belief system through the light of Green's identification of belief systems. At the first dimension, she thought some beliefs as *primary beliefs* and others as *derivative beliefs*. As a primary belief, teacher's belief of clearly presenting mathematics was given as an example. Beliefs on readiness to answer students' questions were also given an example for derivative beliefs. Second dimension was about the strength of the beliefs. She claimed that some beliefs were central, while some were peripheral. She highlighted that some primary beliefs can be more central than derivative beliefs. Third dimension of belief system was that there were clusters in which beliefs were held and also she claimed that theses clusters could be in a relation to some degree.

McLeod (1992) defined belief systems as cognitive components of affective domain. Emotion, attitudes, and beliefs formed the affective domain. He claimed that beliefs were usually stable and developed gradually, and cultural factors played important role in their development.

Beginning teachers' beliefs about mathematics can also affect their decision of teaching in their first years of teaching (Pajares, 1992; Thompson, 1992). Teachers' beliefs about mathematics and mathematics teaching and learning affect their instructional practice (Pajares, 1992; Richardson, 1996; Thompson, 1992). Haser (2009) revealed that preservice and inservice teachers' beliefs differed from each other. She found that since preservice teachers lacked continuous experience in real classroom contexts, their beliefs were developed away from real classroom environments. Findings of her study stressed that teachers' beliefs could be changed after experience. Therefore, beliefs of preservice and inservice teachers would be different from each other (Handal, 2003).

Lester and Garofalo (1987) have stated that teachers' beliefs influence how they teach. For instance, if teachers believe that memorization is important for mathematics, they teach through this belief, or on the contrary, if teachers believe students should understand logical structure of problems instead of memorization, they guide students to learn logical structures. Therefore, understanding beliefs of preservice teachers is very important (Pajares, 1992; Thompson, 1992) because their beliefs will affect their future teaching practice and decisions (Lester & Garofalo, 1987). The present study focuses on preservice teachers' mathematics related beliefs.

2.1 Belief Models

Haser (2006) conducted a study in which she investigated mathematics related beliefs of Turkish preservice and beginning elementary mathematics teachers. She combined three similar belief models proposed by Thompson (1991), Lindgren (1996), and Ernest (1989) as they described and categorized the belief construct similarly. They categorized teachers' beliefs into three levels and these levels were developed in a hierarchy, however, they cautioned that transitions between levels would not be definite. Thompson claimed that teachers' beliefs were formed by the combination of one's conceptions, values, ideologies, and tendencies and these beliefs affected their instructional behaviors. Ernest similarly mentioned about belief as one's conceptions. The difference between their models was that Ernest stated more beliefs about nature of mathematics in his model. Lindgren developed Thompson's framework in her study and added more belief statements. Therefore, researchers' categories of beliefs corresponded to each other. Haser validated that the beliefs addressed in these frameworks could be observed in the Turkish case. The current study employed the combined framework used in her study. Therefore, these frameworks are explained in detail below.

2.1.1 Thompson's Framework

Thompson (1991) conducted a qualitative study about preservice and inservice teachers' mathematics related beliefs. She used "conceptions" instead of "beliefs" and stated that one's beliefs were subset of one's conceptions. Her *conception* definition included definition of beliefs and she defined conceptions as "general mental constructs, encompassing beliefs, rules, mental images, meanings, concepts, propositions and the like" (p.130). She mentioned that teachers' conceptions had a relationship with their practice. She underlined that it would be impossible to distinguish conceptions from knowledge and experience and claimed that teacher's conceptions would be shaped by their schooling and their instructional experiences.

Thompson (1991) developed a framework about teachers' conceptions after her five-year study with seven preservice and five inservice teachers. She grouped conceptions into five different areas for her framework: (i) nature of mathematics, (ii) learning mathematics, (iii) teaching mathematics, (iv) teacher and students' role, and (v) authority for correctness of mathematics and students' knowledge. Under these conceptions, framework categorized beliefs into three developmental levels from poorer beliefs to richer beliefs: Level 0, Level 1, and Level 2. Table 1 shows the characteristics of Thompson's belief levels.

Table 2.1: Framework and the Characteristics of Levels (Thompson, 1991)

Levels	Characteristics
Level 0	Mathematics is basically the usage of arithmetic skills in daily life. For learning mathematics, students practice the procedures the teacher had just demonstrated. Mathematics teaching is developing students' arithmetic skills through memorization of rules.
Level 1	Mathematics is composed of rule and procedures with the principles behind them. For learning mathematics, students put effort to understand the justifications of the procedures. Teaching for conceptual understanding is using pedagogical task and instructional representations to explain isolated set of conceptions.
Level 2	The importance of concepts and centrality of ideas in mathematics are realized through understanding the relationship between them. For learning mathematics, students must involve in constructing mathematical ideas in order to understand them better. Student-centered teaching model is important to teach mathematical concepts.

The complete Thompson (1991) framework is given in Appendix A.

2.1.2 Lindgren's Framework

Lindgren (1996) conducted a qualitative and quantitative study in Finland with preservice teachers. She claimed that mathematics related beliefs were covert mathematical knowledge. She emphasized the relationship between previous experiences and beliefs, and defined the "views" as a combination of conscious and unconscious beliefs. She developed a framework based on Thompson's (1991) levels. The results of her study showed that beliefs could be categorized into three hierarchical levels parallel to Thompson’s levels: (i) rules and routines, (ii) discussion and games, and (iii) open-approach. These categories would usually be shaped according to beliefs about learning and teaching mathematics, and teacher’s and students’ roles. Lindgren’s belief levels are shown in Table 2.

Table 2.2: Framework and the Characteristics of Levels (Lindgren, 1996)

Levels	Characteristics
Rules and Routines	Mathematical knowledge is composed of facts rules and statements. In learning mathematics it is important that pupils practice extensively. In teaching, routine problems are used as often as possible to reach correct answer by familiar methods.
Discussion and games	Mathematics is composed of rules and procedures with the principles behind them. For learning, individual works are important. In teaching, teacher should let students use many learning games.
Open-approach	In mathematics, same results can be achieved in different ways. Mathematical thinking is important to learn mathematics. Verbal problems should be use where the students must be used their knowledge.

The complete Lindgren (1996) framework is given in Appendix A.

2.1.3 Ernest Framework

Ernest (1989) also described beliefs as a combination of one's concepts. He developed an analytic model of knowledge, beliefs, and attitudes of mathematics teachers concerning the nature of mathematics, the processes of teaching, and the process of learning mathematics. In his study the concept "belief" was not defined, rather he used the term "conceptions." Ernest categorized mathematics related conceptions into three as (a) instrumentalist, (b) Platonist, and (c) problem solving, from poorer beliefs to richer beliefs similar to Thompson (1991) and Lindgren (1996). Table 3 shows the characteristics of Ernest's belief levels.

Table 2.3: Framework and the Characteristics of Levels (Ernest, 1989)

Levels	Characteristics
Instrumentalist	Mathematics is a set of tools that includes unrelated facts, rules and skills in order to reach an external end product. Child's linear progress through curricular scheme model. Day to day survival model.
Platonist	Mathematics as a static but combined body of knowledge. Child's mastery of skills model. Conceptual understanding model.
Problem solving	Mathematics as a dynamic, problem-driven, continually expanding field in which there is a process of knowledge. Child's constructed understanding driven model. The pure investigational, problem posing and solving model.

The complete Ernest (1989) framework is given in Appendix A.

The present study documents the construction of a Mathematics Related Belief Scale prepared under the light of these three belief frameworks.

2.2 Preservice Teachers' Mathematics Related Beliefs

Studies on preservice teachers' mathematics related beliefs have increased in the last decade because of the fact that preservice teachers' beliefs are different from inservice teachers' beliefs (Handal, 2003). Since the main purpose of current study was to develop a belief scale for determining preservice teachers' mathematics related beliefs, specific studies which investigated preservice teachers' mathematics related beliefs through using scales were taken into consideration in the below literature review.

Handal (2003) affirmed that preservice teachers had more traditional beliefs than inservice teachers with respect to the teaching of mathematics and they preferred conventional procedures for learning and teaching mathematics. They had narrow views and they were not enthusiastic in adopting the desired trends (AlSalouli, 2004). Preservice teachers tended to believe that mathematics was based on rules and certain procedures that should be memorized (AlSalouli, 2004; Benbow, 1993) and that would lead to single best way to reach an answer (Benbow, 1993; Civil, 1990). Schoenfeld (1992) claimed that preservice teachers considered mathematics as a discipline which had certain rules that should have a definite order. They believed that practicing was very important in teaching and learning of mathematics (Foss &

Kleinsasser, 1996). Preservice teachers also argued the positions such as some people might not have a mathematical mind and there would be no place for intuition in mathematics (Frank, 1990). They believed that mathematical arguments would either be completely right or completely wrong (Civil, 1990; Nisbert & Warren, 2000).

White, Way, Perry, and Southwell (2005) conducted a study to reveal the relationship between preservice primary teachers' mathematics achievement and beliefs about mathematics, mathematics teaching and learning, and attitudes toward mathematics. Researchers implemented an achievement test for measuring mathematics achievement of 83 preservice teachers, a survey for preservice teachers' beliefs about mathematics, learning and teaching mathematics, and also a survey for measuring preservice teachers' attitudes toward mathematics. The belief survey for this study consisted of an 18-item instrument with three responses disagree, undecided, and agree. Belief statements in the instrument were formed by considering the contemporary and modern approaches to mathematics, mathematics learning and teaching. Instrument provided an overview for commonly espoused teacher beliefs. For example, "mathematics is computation" or "mathematics is a beautiful, creative and useful human endeavor that is both way of knowing and a way of thinking" were example belief statements from the belief instrument (White, Way, Perry & Southwell, 2005, p.41). The researchers concluded that preservice primary teachers did not believe that "getting right answer quickly" and "memorizing facts" were critical for learning mathematics. Analysis of the participants' responses showed that preservice primary teachers had constructivist beliefs towards mathematics and learning and teaching mathematics.

Vacc and Bright (1999) examined the changes on preservice elementary teachers' beliefs on learning and teaching and also the influence of introducing Cognitively Guided Instruction (CGI) to preservice teachers. Junior and senior elementary undergraduate students' beliefs were measured by CGI Belief Scale developed by Fennema and colleagues (Fennema, Franke, Carpenter, & Carey, 1993). Researchers observed each 34 participant at their beginning year of profession and an in-depth case study by two inservice teachers were conducted. Vacc and Bright (1999) concluded that preservice elementary teachers' belief scale scores changed little through the semester. They emphasized that belief-scale scores were increased during the semesters of mathematics methodology and student-teaching experience courses. However, results of the case study showed counter evidence for the study. Case study results revealed that preservice teachers' beliefs did not change. At the end of the long-term study, researchers reported that there was a possibility that courses like mathematics teaching methods and school experience could change preservice teachers' beliefs.

Literature provides more specific studies about determining preservice teachers' mathematics related belies. For example, Emenaker (1996) studied the impacts of a problem solving based mathematics methods course on preservice elementary teachers' beliefs about mathematics and how to teach mathematics. His study categorized beliefs into five as time, memory, step, understand, and several. For instance, category several had items as “There is only one correct way to solve any problem” or time as “If a math problem takes more than 5 - 10 minutes, it is impossible to solve” (Emenaker, 1996, p.79). The study addressed that there was a significant positive change on all belief categories except time. Also, Lloyd and Frykholm (2000) surveyed 50 preservice mathematics teachers’ beliefs about nature of mathematics and their future classroom practices. Results revealed that their beliefs were influenced by their past experiences as students and their beliefs about mathematics during schooling. After different teaching methods and strategies were taught, it was observed that those prospective teachers’ beliefs on how to teach mathematics had changed.

Hart (2002) claimed that there were considerable evidences about how teachers’ teaching of mathematics was influenced by their beliefs about mathematics. Therefore, teacher education programs should assess effectiveness of their consistent philosophy of learning and teaching. Throughout this perspective, he conducted a study with 14 preservice elementary teachers over three semesters. The purpose of this study was to identify relationships between preservice teachers’ beliefs about the reform movement in mathematics education and taking mathematics method course. Preservice teachers took 6 hours mathematics course and 6 hours mathematics teaching course continually over three semesters. Before and after these courses, participants completed 30-item Mathematics Belief Instrument (MBI) with three parts measuring participants’ beliefs about learning and teaching mathematics through the philosophy of NCTM standards, general beliefs about learning and teaching mathematics, and participants' impression of the effectiveness of mathematics teaching and learning. The results addressed that mathematics method course changed teachers' beliefs. Hart (2004) conducted new study for the purpose of using MBI to evaluate the mathematics method course by the belief point of view. Since the number of participants (14) in the first study was low, he conducted this new study by 89 participants. MBI was administered before and after the method course and pre and post test results were compared to understand whether or not mathematics method course had a significant effect on preservice teachers' mathematics related beliefs. Results of the study concluded that mathematics method course changed the preservice teachers' beliefs and self-efficacy in a positive way. He highlighted that teacher education programs helped to develop preservice teachers' mathematics related beliefs; therefore, it was important to examine effects of method courses on preservice teachers' beliefs.

National Council of Teaching of Mathematics (NCTM) (2000) emphasized the importance of the technology use in mathematics lessons and recommended increasing the place of technology in curricula. Standards highlighted that students could learn mathematics more deeply when technology would be wisely used. Wachira, Keengwe, and Onchwari (2008) conducted a study depending on this standard. Their study focused on determining preservice teachers' beliefs and conceptions about the proper use of technology in the mathematics classroom. Researchers concluded that preservice teachers had limited beliefs on the proper use of technology. Technology was not seen as a powerful tool to make mathematics more meaningful. Parallel results were reported with the Fleener, Pourdavood, and Fry's (1995) study's results which were conducted for measuring preservice teachers' beliefs about technology use in mathematics. Twenty-item Likert type scale including items related to the usage of calculators in the mathematics class was administered to 78 preservice teachers. The results had revealed that 55% of the preservice teachers believed that students should have mastery on concepts before they would be allowed to use calculators.

2.2.1 Summary

The studies summarized above examined preservice teachers' mathematics related beliefs from different perspectives which were important for the current study. Since MRBS was developed to measure preservice teachers' more general beliefs than specific beliefs, literature about difference between teachers' beliefs and preservice teachers' beliefs, about problem solving beliefs, about technology beliefs, and about the nature of mathematics beliefs provided important belief statements for developing MRBS.

As seen from the literature review, White, Way, Perry, and Southwell's (2005), AlSalouli's (2004), Benbow's (1993), and Civil's (2000) studies' results contradicted each other. While White and colleagues found that memorization and getting right answer was not important for preservice teachers, others addressed the opposite findings in their studies. Fleener's (1995) qualitative study and Wachira, Keengwe, and Onchwari's (2008) quantitative study provided a general point of view about preservice teachers' beliefs about technology use in mathematics and found very similar results. Since the new curriculum in Turkey was developed according to constructivist approach (MEB, 2008) and technology usage gained more importance with this development, understanding preservice teachers' beliefs about technology usage became essential. Belief statements about technology usage in MRBS were formed based on these studies and the theoretical framework.

Problem solving approach and steps of problem solving was also another important part of the new curriculum (MEB, 2008). Hence, preservice teachers' problem solving beliefs became crucial in implementing the curriculum when they would become a teacher. There were several belief statements about problem solving in MRBS and these statements were formed by combination of theoretical framework and Emenaker's (1996) study.

Handal (2003) review about teachers' mathematical beliefs revealed that preservice teachers' beliefs should be examined separately from inservice teachers' beliefs. Moreover, studies about the effects of teacher education courses on preservice teachers' mathematics related beliefs addressed the possible influence of these courses (Hart, 2002). Therefore, belief statements for MRBS were formed considering the possible influence of the teacher education program courses.

The general interpretation of these studies showed that preservice teachers' mathematics related beliefs, especially about the nature of mathematics, were more likely to be traditional. Most of these studies investigated preservice teachers' beliefs by implementing Likert type scales with different number of responses and most of the scales were developed for the specific study (Fennema, Carpenter & Peterson, 1987; McGinnis, Randy, Kramer, Steve, Watanabe & Tad, 1998). The steps of scale development and implementation in those studies guided the current study.

2.3 Belief Studies in Turkey

Several belief studies have been conducted in Turkey by both preservice and inservice teachers. The researchers focused on specific mathematics related beliefs of preservice teachers in these studies such as mathematics self-efficacy beliefs. Besides efficacy belief studies, beliefs about problem solving and technology usage were other important research topics for Turkish researchers. The instruments for investigating preservice teachers' beliefs in those studies guided the development of MRBS.

Haser (2006) conducted a qualitative study to determine preservice teachers' mathematics related beliefs and possible factors affecting those beliefs. She collected data from a total of twenty 2^{nd}, 3^{rd}, and 4^{th} year elementary mathematics education program students. In this study, she sought a possible difference about nature of mathematics, teaching, and learning mathematics beliefs through year levels. Study concluded that preservice teachers' mathematics related beliefs did not vary across the year levels. Their mathematics related beliefs were found to be teacher-centered and their experiences in the teacher education program had a limited effect on their mathematics related beliefs. Moreover, Haser addressed that the participants believed that if their students would like them as a teacher, then they would also enjoy mathematics. This belief emerged distinctively from the literature.

Haser and Doğan (2009) conducted a study with the purpose of investigating prospective elementary preservice teachers' mathematics related beliefs and examining the effect of year level on preservice elementary mathematics teachers' mathematics related beliefs. They administered Likert-type mathematics related beliefs scale including 38 item developed by researchers based on the combination of three belief frameworks used in the study by Haser (2006). Scale was translated by researchers and then three other researchers were examined translations to confirm content of the scale. They conducted pilot study to 34 preservice mathematics teachers and scale was administered at the beginning of the fall semester of 2007. They employed one-way ANOVA to understand the year level effect on prospective teachers' mathematics related beliefs. The results of the one-way ANOVA showed that there was significant difference between the belief scores of prospective teachers from different year levels and effect size concluded that mean score differences were large. They found that 4^{th} year students mean score was higher than 3rd and 2nd year students, however, there was no significant difference between the 1st year prospective teachers' belief scores and the other year level students' scores. They concluded that fourth-year students' beliefs can be affected by the course on teaching methods of specific mathematics content they had recently enrolled.

Baydar (2000) conducted a study to determine preservice mathematics teachers' beliefs in Turkey. He compared the beliefs of preservice teachers from two universities in Ankara in order to investigate the differences between these preservice teachers' beliefs about the nature of mathematics and teaching mathematics. This study concluded that preservice teachers would form their beliefs as a result of their experiences in the classroom as a student and understanding their beliefs through valid and reliable measures would be the most important step in changing these beliefs. Therefore, determining preservice teachers' beliefs correctly could help teacher educators in influencing their further beliefs.

Boz (2008) implemented an open-ended questionnaire to 46 preservice teachers from secondary mathematics teacher education program in order to identify preservice teachers' beliefs about the instructional approaches used in the mathematics classroom, teacher's role, and the student-student and student-teacher interaction in the classroom. The researcher organized the responses into four different groups: (a) traditional beliefs, (b) mix of traditional and non-traditional beliefs, (c) non-traditional beliefs, and (d) not codeable responses. Five participants which were the most representative of these four groups were selected as cases. He investigated those five cases in depth and stated that secondary preservice mathematics teachers had rather student-centered beliefs. They believed that teachers should guide students during the lessons. Boz also addressed that previous experiences as a student and teacher education program courses affected preservice teachers' beliefs about mathematics.

Kayan (2007) examined preservice teachers' problem solving beliefs and investigated whether or not gender or universities attended had significant effect on their beliefs. Data was collected from 244 senior undergraduate students by demographic information sheet, questionnaire items, and non-routine mathematics problems. The results of the study illustrated that preservice elementary mathematics teachers had positive beliefs about mathematical problem solving. However, they still had several traditional beliefs related to the importance of computational skills in mathematics education and following predetermined sequence of steps while solving problems.

2.3.1 Summary

Mathematics related belief studies in Turkey have gained attention of researchers and specific dimensions of preservice teachers' beliefs have been investigated. The synthesis of those studies demonstrated that Turkish preservice teachers generally had traditional mathematics related beliefs. Yet, the study conducted by Boz (2008) showed that preservice secondary mathematics teachers he studied had student-centered beliefs. Considering the importance of problem solving approach in the new curriculum, preservice elementary mathematics teachers' beliefs about problem solving gained importance. Preservice teachers were not sure about if problem solving was basically implementing step by step procedures (Kayan, 2007).

The influence of teacher education program courses on preservice teachers' mathematics related beliefs were also investigated in the Turkish case. These studies claimed that preservice teachers' beliefs were formed during their pre-college schooling and renewing teacher education programs could be helpful for changing their beliefs (Baydar, 2000; Haser, 2006).

2.4 Studies on Developing Mathematics Related Belief Scale

Several researchers have developed scales for measuring teachers' beliefs. Capraro (2001) indicated that teachers' beliefs were essential in understanding teachers' pedagogical and content tasks and for managing their knowledge in relation to those tasks. She conducted a study for the purpose of ongoing use of valid and reliable instrument to longitudinally measure teacher candidates' attitudes and beliefs in reform-based mathematics and science teacher preparation program. She initially used a 48-item Likert-type instrument *Mathematics Belief Scale* (MBS) prepared by Fennema, Carpenter and Loef (1990) adapted from Fennema, Carpenter and Peterson (1987) with four subscales; "(a) the beliefs of teachers' about how children learn mathematics, (b) how mathematics should be taught, (c) the relationship between learning and concepts and procedures, and (d) what should provide the basis for sequencing topics in addition and subtraction instruction" (p.12). Analyses of the implementation of the scale resulted in high reliability and three factors related to teachers' beliefs about (a) how children learn mathematics, (b) how mathematics should be taught, and (c) the relationship between learning and concepts and procedures. After the analysis, the instrument was modified in order to shorten MSB and eliminate the repeated items. As a result, 48-item scale was revised into 18-item more user-friendly scale. The study concluded that the instrument measured beliefs of teachers about how students learn the role of the teacher in this process, and teacher practices. Teachers' beliefs about the nature of mathematics were not the focus.

The instrument "*Attitudes and Beliefs about the Nature of and the Teaching of Mathematics and Science*" was developed in order to investigate the nature of mathematics and the mathematics teaching beliefs of preservice teachers who were studying at a mathematics and science teacher education program (McGinnis, Randy, Kramer, Steve, Watanabe, Tad, 1998). The instrument was administered to 104 participants twice, during the consecutive fall and spring semesters, and repeated-measures t-test design was used to analyze data. Validity and reliability of the instrument were indicated as high and instrument was introduced as proving useful in providing "longitudinal topography" of the attitudes and beliefs of the teacher candidates.

Depending on NCTM's curriculum and evaluation standards for school mathematics, a belief instrument was developed by Zollman and Mason (1992). Instrument's items were directly related to measure teachers' beliefs about standards. Sixteen standards out of 54 are selected for this belief instrument and pilot study was conducted to develop the instrument. Pilot study results showed that researchers should highlight the aspects of the items to prevent distractions, therefore, important words are written with capital letters to underline the main idea of the item. Yet, this approach was not used in the current study.

2.4.1 Summary

The above studies have shown that constructing a belief scale was generally based on the specific characteristics of the preservice teachers studied such as the teacher education program and the mathematics curriculum used in specific systems. Hence, there seemed to be a need for developing new instruments for specific contexts. The differences and similarities of these studies guided the current study. One of the common traits of these studies was that they usually focused on beliefs about nature of mathematics, learning mathematics, and teaching mathematics. Most of the instrument development studies divided their scales into these categories and studies were shaped around these categories of beliefs. Researchers were able to identify beliefs according to these sub-dimensions of mathematics related beliefs.

Most of the instruments in these studies were developed for and applied to both preservice and inservice teachers. Instruments were developed according to the common responses. However, literature indicated that beliefs of preservice and inservice teachers differed (Handal, 2003). From that point of view, the current study was focused on developing a mathematics related beliefs scale for preservice elementary mathematics teachers.

In brief, a belief scale considering the specific characteristics of Turkish elementary preservice mathematics teachers was appeared as essential in investigating their beliefs and determining the experiences in teacher education programs. As cited before, Boz (2008) and Baydar (2000) also developed two different belief scales to identify preservice teachers' beliefs in Turkey. However, Boz's belief scale was an open-ended belief scale and would not be useful in determining a large group of preservice teachers' mathematics related beliefs. Baydar's instrument was prepared to identify the differences in beliefs of preservice teachers from two universities. Development of MRBS for this study considered the findings of these studies. The present study focused on addressing overall mathematics related beliefs of a larger group of Turkish preservice elementary mathematics teachers. Based on these assertions, this study is developed to around the idea of understanding preservice mathematics teacher' mathematics related beliefs.

CHAPTER 3

METHODOLOGY

The methodology of the study is explained in this chapter in six main parts. First, the research design is explained. Second, sampling method of the study and the participant characteristics are presented. Next, data collection instrument is explained in detail. Then, development procedure of the instrument is explained and afterwards, data analysis process is given. At the end of the chapter, internal and external validity of the study and validity threats are explained.

3.1 Research Design

The first aim of this study was to develop a valid and reliable "Mathematics Related Belief Scale" (MRBS) to measure preservice mathematics teachers' mathematics related beliefs. The MRBS was developed and piloted through the processes explained in detail below. Exploratory Factor Analysis, one of the multi-variable analysis technique (Tavşancıl, 2006), was conducted in order to determine the validity and sub-domains of the MRBS. Factor analysis, a technique of data reduction (Pallant, 2005), was used to describe variables by a few factors (Fraenkel & Wallen, 2005). Exploratory factor analysis was used to gather information about interrelationships among items (Pallant, 2005). Principal Components Analysis technique was used to "transform items into smaller sets of linear combinations"

(Pallant, 2005, p.273). By the help of factor analysis, researcher summarized and categorized large number of scale items into smaller sets.

The second aim of this study was to analyze the impact of gender and year level on the preservice mathematics teachers' mathematics related beliefs. For this purpose, two-way between groups ANOVA was used to identify the impact of gender and year level. This method exposed the impact of gender, year level, and gender-year level interaction on belief separately. Moreover, descriptive analysis results of this method also explained the Turkish preservice mathematics teachers' mathematics related beliefs.

Consequently, different quantitative research techniques were used for each research question in this study. Table 3.1 shows the overall research design of this study.

Table 3.1: Overall Research Design

1. Research Design	Survey research
2. Sampling	Convenient sampling
3. Instrument	Mathematics Related Belief Scale (MRBS) developed by researcher
4. Data Collection Procedure	584 preservice elementary mathematics teacher students from 10 universities
5. Data Analysis Procedure	Exploratory Factor Analysis, two-way between groups ANOVA

3.2 Population and Sample of the Study

The target population of this study was all preservice elementary mathematics teachers in Turkey. There were 44 universities having Elementary Mathematics Education (EME) program in Turkey at the time of the study. Since the population was large and connecting with all preservice elementary mathematics teachers in Turkey required time and financial resources, the accessible population was determined as the preservice elementary mathematics teachers at 10 universities at seven regions in Turkey.

The universities were selected based on the convenience of reaching a contact person at the EME programs in both public and private universities. First, universities which had EME program were determined at each of seven regions in Turkey. Then, universities which were convenient to contact were selected by taking into consideration of participation of at least one university from each region. Participant universities of this study were Middle East Technical University (METU), Hacettepe University, Başkent University, Abant İzzet Baysal University, Dokuz Eylül University, Balıkesir University, Samsun Ondokuz Mayıs University, Burdur Mehmet Akif Ersoy University (MAKÜ), Gaziantep University, and Van Yüzüncü Yıl University.

A total of 584 preservice elementary mathematics teachers participated in the study. Since sample size was large and selected from seven regions of Turkey, the sample could be considered as representative of all preservice elementary mathematics teachers; however, convenient sampling was a limitation for generalization for this study.

Out of 584 participants, 303 were third year and, 281 were fourth year students. In each university, percentages of the participants were different because MRBS could not be applied to all fourth and third year students in each university. Volunteering students at the participating universities formed the sample of the study. Nearly half of the sample was third year students (51.9 %) and nearly half of them were fourth year students (48.1%). Table 3.2 shows the detailed distribution of gender and year level for each university.

Table 3.2 also shows the gender and university distribution of 584 participants. Out of 584 participants, 398 were female (68.2 %) and 186 were male (31.8 %). For each university, the number of female participants was more than the number of male participants.

Table 3.2: University Gender and Year Level Distributions of the Participants

	3rd year	4th year	Total	Female	Male	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
METU	32(57.1)	24 (42.9)	56 (9.6)	42(75)	14(25)	56 (9.6)
Hacettepe	51(52.0)	41(48.0)	92(15.7)	67(72.8)	26(27.2)	92(15.7)
Başkent	17(48.5)	18(51.5)	35(6.0)	25(71.4)	10(28.6)	35(6.0)
Abant İzzet Baysal	19(86.3)	3(13.7)	22(3.8)	13(56.7)	9(43.3)	22(3.8)
Dokuz Eylül	37(53.6)	32(46.4)	69(11.8)	51(73.9)	18(26.1)	69(11.8)
Balıkesir	58(37.6)	96(62.4)	154(26.3)	91(59)	63(41)	154(26.3)
Ondokuz Mayıs	54(60.6)	35(39.4)	89(15.2)	65(73)	24(27)	89(15.2)
MAKÜ	15(100)	0(0)	15(2.5)	10(66.6)	5(33.4)	15(2.5)
Gaziantep	13(56.5)	10(43.5)	23(3.9)	14(60.8)	9(39.2)	23(3.9)
Yüzüncü Yıl	22(75.8)	7(24.2)	29(5.2)	21(72.4)	8(27.6)	29(5.2)
Total	303(51.9)	281(48.1)	584(100)	398(68.2)	186(31.8)	584(100)

3.3 Instrumentation

In this part of the chapter, process of developing the instrument MRBS was explained in detailed. Data collection instrument and construction of instrument procedures were addressed.

3.3.1 Data Collection Instrument

In the present study, Mathematics Related Belief Scale (MRBS) was administered as the data collection instrument. It was constructed by the researcher considering the combination of excessive literature review about mathematics related beliefs and an instrument developed by Haser and Doğan (2009) based on the study Haser (2006) conducted. The MRSB developed by Haser and Doğan (2009) is given at Appendix B.

MRBS was consisted of two main parts: (a) demographic information and (b) mathematics related belief scale. In the demographic part of the scale, participants' gender, university, and year level in the EME program were asked. These questions were asked in order to help the researcher to analyze possible differences in beliefs in terms of gender and year level.

In the mathematics related beliefs scale part, participants were asked to indicate their agreement with the belief statements about the nature of the mathematics, learning mathematics, and teaching mathematics. While some of these statements were parallel to the constructivist view, the others were more in traditional view. Scale was scored as 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, and 5= Strongly Agree. Five was valued as the highest score whereas one was the lowest for each item in the scale. Each participant could get maximum 160 point and minimum 32 point in this scale. Developing procedure of the MRBS is presented below.

3.3.2 Development of the MRBS

Development of measuring instrument procedures consisted of three main parts. First, literature review procedure was explained in detail, and then preparation of the scale's items was identified. Following, expert opinions were shared. Lastly, pilot study's details were explained in this part.

3.3.3 Literature Review of Mathematics Related Belief Scales

Before constructing the latest version of the MBRS, an extensive literature review was completed. Databases such as EBSCOhost, ERIC, and ULAKBIM were explored to reach studies investigated preservice and inservice mathematics teachers' mathematics related beliefs as well as book chapters, articles, and journals both in Turkey and abroad. Few instruments were found specifically designed for assessing the general beliefs of teachers that were prepared by Turkish researchers. Most of the instruments were derivations of each other and were prepared for investigating 4^{th} beliefs on specific areas such as problem solving beliefs (Kayan, 2007) and self-efficacy beliefs (Işıksal, 2005). The belief statements in these scales were sought for constructing a belief scale which would measure beliefs about (a) the nature of the mathematics, (b) teaching mathematics, and (c) learning mathematics. Items were prepared based on these dimensions. Details of preparation of items are given in detail below.

3.3.4 Preparation of Scale's Items

There were several steps followed during the construction and development of the scale items used in this study. First of all, the items in the scale developed by Haser and Doğan (2009) were reviewed while an extensive literature review on preservice teachers' and inservice teachers' mathematics related beliefs were carried out. Their scale was constructed specifically to measure mathematics related beliefs held by preservice and inservice elementary mathematics teachers. It was a 38-item Likert type scale of 5 possible responses ranging from strongly agree to strongly disagree. Items were constructed to assess beliefs about nature of mathematics, learning mathematics, and teaching mathematics.

The comparison of the scale items with the literature review showed that 12 of the items exactly matched the belief statements addressed in the literature and the other items reflected the beliefs widely mentioned in the literature. The mathematics related beliefs that could not be measured by this instrument were sought in the literature and one item was added to the MRBS. The suggested changes resulted in a 39-item belief scale. The second version of 39-item MRBS is given in Appendix C.

3.3.5 Experts' Opinions

The next step of preparing scale items was gaining experts' opinions. The new MRBS consisted of 39 items and these items were reviewed by four mathematics education researchers. Researchers examined items according to their content and comprehensibility. They interpreted items for whether they measure beliefs about nature, learning, and teaching mathematics or not. They also commented on the clearness of the belief statements of the scale. The review process revealed that there were some problematic and repeated items.

The first review was conducted by the researchers of the initial MRBS. They suggested that 14 items should be removed from the scale due to the unclear belief expression or an overlap with a very similar item. Changes in wording of some of the items were also suggested. In order to address the beliefs stated in those items, seven items were written by the help of the literature review. This review process ended with a second version of MRBS with 32 items (See Appendix D).

The second version of MRBS was examined by the writers of the initial version and the researcher. The other researchers studied and implemented the initial version of the MRBS to a small number of preservice teachers and also asked them to indicate whether they have understood the expressions on each of the items or not. Under the light of the suggestions, some changes were done on MRBS. The problematic items about the nature of mathematics and all problem solving items were removed from the scale. Instead, new items were written based on the literature. Four items related to the use of materials were decreased to two, as one was related to the frequency of using materials and the other was about the purpose of using these materials in lessons. Items related to beliefs about finding correct answers were combined in one item. Two items about drill and problem solving practices were removed from the scale and one new item was written for these items. Finally, items with unclear expressions such as “pedagogical approaches” were removed from the scale.

The new 32-item Likert type MRBS was the third version of scale. Since several changes were done on the MRBS, two other mathematics education researchers’ opinions about MRBS were gathered to confirm content validity of the scale. These reviewers underlined that words such as “only” and “main” were not suitable expressions for scales. Those kinds of expressions were removed from scale. They also suggested a better translation of certain mathematical terms in the items. As a final comment, these reviewers stated that the items in the scale adequately represented the mathematics related beliefs of preservice elementary mathematics teachers.

The reviewers’ opinions about the construct validity and clarity of the MRBS resulted in a reviewed third version of the 32-item MRBS. A recent graduate of an EME program reviewed the MRBS in terms of the clarity of the items. The scale was analyzed by a Turkish language expert to identify the problems in the language of the items and suggested changes were completed.

Following the preparation of scale's items, the MRBS was piloted through the process described below. The after-pilot MRBS was printed on optical forms. The optical version of the MRBS included brief information about the purpose of the study, the contact information of the researcher and her supervisor, and how researchers would use data. It was highlighted that their voluntary participation was crucial for this study and they could leave the study at any moment.

3.3.6 Pilot Study

Pilot study is an important process for developing scales. The construct validity, whether a scale measures or correlates with scientific construct (Pennington, 2003), and reliability of the scale could be tested with pilot study.

The third version of MRBS was administered to 242 preservice teachers from three universities in Ankara, Tokat, and Bayburt, which were different than the universities of the main study. Sampling of the pilot study was chosen conveniently as the researcher had access to these universities and these participants would not be implemented the final version of the scale in the main study. MRBS was administered to a total of 112 preservice primary teachers and elementary mathematics teachers at Gazi University by the researcher. MRBS was implemented for the pilot study to 130 preservice primary teachers in Bayburt and

Gaziosmanpaşa Universities by the graduate assistants in these universities by providing them with verbal and written instructions on the implementation. The preservice teachers in the pilot study were informed that the participation was voluntary and they could leave the study at anytime they would want to. Distribution of pilot study participants for each university in terms of gender and year level is given in Table 3.3. Third year participants constituted the 55.8% of the sample, whereas fourth year participants constituted the 44.2%.

Table 3.3: University – Gender and Year Level Distributions of the Participants for Pilot Study

	Female	Male	Total	3rd Year	4th Year	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Gazi	83(74.1)	29(25.9)	112(46.3)	63(56.2)	49(43.8)	112(46.3)
Gaziosmanpaşa	63(67.0)	31(33)	94(38.8)	36(38.2)	58(61.8)	94(38.8)
Bayburt	13(36.1)	23(63.1)	36(14.9)	36(100)	0(0)	36(14.9)
Total	159(65.7)	83(34.3)	242(100)	135(55.8)	107(44.2)	242(100)

Principal Component Analysis (PCA) was conducted to identify construct validity and sub-domains of the scale. There was no common agreement on the needed sample size for factor analysis but researchers recommend that larger sample size would result in better factor structure (Pallant, 2005). Considering the number of items in the instrument and Nunnaly's (1978) recommendation that 10 cases were needed for each item for the factor analysis, more than 320 participants were required for the study (as cited in Fraenkel & Wallen, 2006). Number of pilot study's participants (242) did not match this recommendation; however, analysis gave an idea about correlations between items and number of sub-domains of the scale. Before conducting PCA, negatively worded items (items 3, 4, 6, 7, 8, 9, 10, 20, 21, 23, 28, and 32) were reversed. The result of the factor analysis showed that there were five components with eigenvalue over 1 (Total Variance Explained table was given in Appendix E); however, screeplot (See Figure 3.1) made a sharp break after the 2nd and 3rd components. Component matrix also supported screeplot's results that items were loaded into two components.

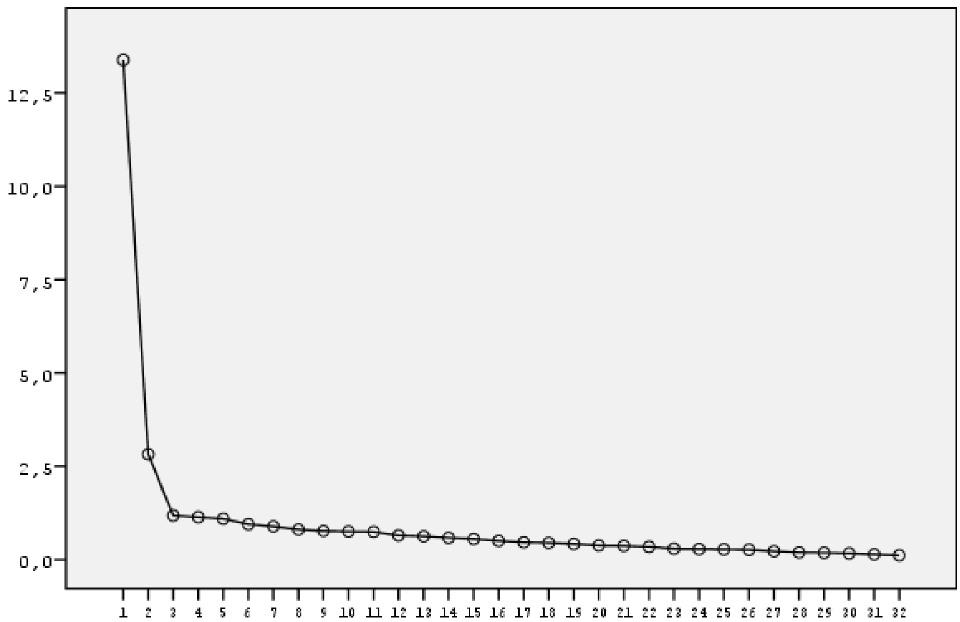

Figure 3.1 Scree Plot of Eigenvalues of Pilot Study

Items 1, 2, 3, 4, 5, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 24, 25, 26, 27, 28, 29, 30, 31 were loaded under first component and items 6, 7, 8, 10, 21, 23, 32 were loading under second component. Items loaded under the first component were generally parallel to the constructivist view; therefore, Component 1 was named as "Constructivist Beliefs" and items loaded under second component were generally parallel to the traditional approach in mathematics; therefore, it was named as "Traditional Beliefs."

In educational research studies, Cronbach's alpha (α) was one of the most common used internal consistency indicators. Its value changes between 0 and 1, with higher values indicating greater reliability (Green, Salkind & Akey, 2000) and values over .70 is generally preferred in order to have a reliable scale (Pallant, 2005). For the present study, Cronbach alpha coefficient was computed for the determining the internal consistency. For the pilot study of MRBS, it was calculated for Constructivist Beliefs and Traditional Beliefs as 0.835 and 0.737 respectively, which indicated a satisfactory reliability and internal consistency between items. It was highlighted that Cronbach alpha addressed how free the scores gathered from an instrument would be from random error (Pallant, 2005). Therefore, Cronbach alpha value of 0.835 meant that 83% of the variance depended on the true variance in the construct measured and 17% depended on the error variance, pointing a high reliability. Similarly for Traditional Beliefs, alpha value of 0.737 meant that 73% of the variance depended on the true variance in the construct measured, and 27% depended on the error variance pointing a high reliability.

The number of participants was not over 320, but the reliability of the scale was high, therefore, researcher did not change items and the same MRBS was implemented in the main study. It was expected that same items would be loaded into the same component in main study. As a result, MRBS's sub-domains were identified and named after the main study.

3.4 Data Collection Procedure

Depending on the experts' opinions and the pilot study, developed MRBS was administered to 584 preservice elementary mathematics teachers. The data was collected from the 3rd and 4th year preservice elementary mathematics teachers selected from ten universities in Turkey. Convenient sampling method was used while selecting these universities. The MRSB was administered to the preservice elementary mathematics teachers at the end of the second semester of 2009- 2010 academic year in June.

Prior to applying MRBS to at the universities, researcher applied to ethics committee of Middle East Technical University and Hacettepe University. Both universities' ethical committees approved that the scale could be implemented to the students. Researcher got verbal approvals from chairpersons of Departments of Elementary Education at other universities. They examined the scale and then they gave permissions for the implementation of the MRBS.

Data collection at universities in Ankara (METU, Hacettepe, and Başkent) was conducted by the researcher. Researcher got permissions from the course instructors to implement MRBS in the last 15 minutes of their lessons. Before applying MRBS, the researcher explained the purpose of the study, how data will be used, and how they can get information about the results of the study to the preservice teachers. It was reminded that the MRBS was a 5-point-Likert type scale from strongly disagree to strongly agree. Moreover, researcher highlighted that participation in this study should be voluntary.

The researcher contacted graduate assistants from Elementary Mathematics Education Programs at the other universities. She explained the purpose of the study and details of the implementation to them on the phone and provided them by detailed written directions for what they should be reminding the participating preservice teachers before the implementation. They implemented the MRBS in the last 15 minutes of their course hours. MRBS delivered to these universities via mail and was returned in the same way.

3.5 Analysis of Data

Data analysis of MRBS was examined into four main parts: (a) factor analysis of data, (b) internal and external validity analysis of data, (c) reliability analysis of data, and (d) the effect of gender and year level in EME program procedures.

3.5.1 Principal Component Analysis Procedure

For the main study, data reduction and descriptive statistics were conducted to investigate the two main research questions by using SPSS 15 program. First of all, negatively worded items are reversed as 1 to 5 and 5 to 1. Items 3, 4, 6, 7, 8, 9, 10, 20, 21, 23, 28, and 32 were determined as negatively worded items and reversed one by one. After that procedure, Factor Analysis was conducted to identify sub-domains of MRBS and sub-domains of MRBS were named. Then, descriptive statistic results were used to determine Turkish preservice elementary mathematics teachers' mathematics related beliefs. Means of each item was gathered and participants' agreement level with the belief statement was considered.

3.5.2 Internal and External Validity Analysis Procedures of Data

The term validity, as used in research, refers to the appropriateness, meaningfulness, correctness, and usefulness of any inferences a researcher draws based on data obtained through the use of an instrument" (Fraenkel & Wallen, 2006, p.150). In other words, it is the "best available approximation to the truth or falsity of a given inference, proposition or conclusion" (Trochim, 1991, p.33). Internal validity and external validity were the two main validity types that should be analyzed (Fraenkel & Wallen, 2006). Procedure of analysis of these validities had two main steps; analysis of validity threats and analysis of validity evidences.

3.5.2.1 Analysis of Validity Threats

In this part of the chapter, internal validity threats and external validity of the study were explained.

3.5.2.1.1 Internal Validity Threats

There are four main threats (a) mortality, (b) location, (c) instrumentation, and (d) instrument decay for internal validity for survey studies (Fraenkel & Wallen, 2006).

Mortality threat was described as the “dropout of the subject from the study” (Fraenkel & Wallen, 2006, p.170). In this study, MRBS was administered to participants once in each university. It was administered and collected after 15 minutes period. Therefore, mortality was not a threat for this study because there was no dropout of participants.

Fraenkel and Wallen (2006) stated that location that the instruments were implemented might influence the responses. They suggested that if the location would be the same for all participants that would help preventing location threat (Fraenkel & Wallen, 2006). The data of study was collected from ten different universities from eight different cities in Turkey. MRBS was implemented to students in their universities and in their classrooms. Since data collected from different cities, it was impossible to hold location constant for each participant .

However, the scale was implemented to the participants in their classrooms at their universities, a place they were familiar with.

Changes in the instrument might influence the outcomes and this threat was named as instrumentation threat. It was stated that instrumentation threat usually occurs in the pretest-posttest conditions (Trochim, 1991). For this study, only one instrument (MRBS) was administered to participants only once. Since there were no change in instrument or implementation method and only one implementation was conducted, instrumentation was not a threat for this study.

Instrument decay threat addressed the changes in the nature of the instrument generally in the long instruments and interviews as participants would likely to be tired (Fraenkel & Wallen, 2006). For this study, MRBS was a rather short and Likert type scale, and it took at most 15 minutes to complete scale. Therefore, instrument decay was not an internal validity threat for this study.

3.5.2.1.2 External Validity

The term external validity was described as the "extend to which the results of a study can be generalized from a sample to a population" (Fraenkel & Wallen, 2006, p.111). The target population of this study was determined as all preservice elementary mathematics teachers (EME) in Turkey. There were 44 universities having EME programs and 10 of these universities were the participants of this study which addressed that approximately 22 percent of the universities participated in the study. Sample of the study was consisting of 584 participants which could be accepted as a large sample for this study. Despite the fact that the number of participants and number of universities would seem large enough for generalization, external validity was a threat for this study because convenient sampling method was used for this study.

3.5.2.2 Analysis of Validity Evidences

There were three main evidences which must be controlled to understand whether MRBS was valid or not. For determining validity of MRBS content-related evidence of validity and construct-related evidence of validity were checked.
Content validity of the test was addressed by the review of four mathematics education researchers about content and logical structure of MRBS. They reviewed both the initial and the latest versions and concluded that the items reflected the preservice teachers' mathematics related beliefs adequately.

The results of the pilot study PCA were used to determine construct validity evidence. Factor analysis was a method which explained variability between observed variables (Bryant & Yarnold, 1994) and PCA provided the linear combination among items (Pallant, 2006). Results of the PCA showed that there were two components of MRBS and almost all items' correlation coefficients were above .3 as recommended by Tabachnick and Fidell (2001). Only item 4, item 9, item 10 and item 13 had correlation coefficients (.272, .165, .299 and .228, respectively) lower than .30 but were very close to .30. The initial base for the MRSB was a combination of three models about preservice teachers' mathematics related beliefs. Two of these models were tested and their validation was ensured. The third model was a theoretical model. Therefore, MRBS could be considered to depend on validated and theoretical models.

3.5.3 Reliability Analysis Procedures of Data

Cronbach alpha coefficient was computed for determining the internal consistency of the MRBS in the actual study. It was stated as the Cronbach alpha coefficient of a scale should be above 0.70 (Pallant, 2005) in order to have a reliable scale. Detailed information about reliability analysis was given in the result chapter.

3.5.4 Two-way Between Groups ANOVA Tests

After the first research questions was analyzed, two-way between groups ANOVA test was conducted to identify whether there was a significant difference on preservice elementary mathematics teachers' mathematics related beliefs in terms of gender and year level in the EME program. Demographic information was used to reveal these differences. Moreover, two-way ANOVA test provided information about whether there was a significant effect of gender and year level interaction on students' beliefs.

CHAPTER 4

RESULTS

Results gathered from analysis of data are represented in this chapter. This chapter includes mainly two parts. In the first part, demographic information are given. In the second part, results regarding the research questions are presented. For research question 1, Factor Analysis results are reported to determine the validity of Mathematics Related Belief Scale and indicate the sub-domains of the scale. Afterwards, descriptive statistics are given to indentify beliefs of Turkish preservice mathematics teachers. Lastly, two- way between groups ANOVA are indicated to report whether there is a significant difference on teacher beliefs in terms of gender and year level in EME program.

4.1 Analysis of Demographic Information

In this study, three main demographic information were asked to participants: (a) gender, (b) year level in EME program, and (c) university. Table 4.1 gives the percentages of students from different universities.

Table 4.1: Universities and Distributions of the Participants

	Number of participants	Percentage (%)
METU	56	9.6
Hacettepe	92	15.7
Başkent	35	6.0
Abant İzzet Baysal	22	3.8
Dokuz Eylül	69	11.8
Balıkesir	154	26.3
Ondokuz Mayıs	89	15.2
MAKÜ	15	2.5
Gaziantep	23	3.9
Yüzüncü Yıl	29	5.2
Total	584	100

The male and female distributions of participants were analyzed for each university. Among all participants, the number of female participants (398) was more than the number of male participants (186). Table 4.2 presents the gender distribution of participants among the universities. The third and fourth year EME students were the scope of the study. The number of third year participants (303) and the number of fourth year participants (281) were very close to each other. For Mehmet Akif Ersoy University (MAKÜ), elementary mathematics education program had recently opened and there were no 4^{th} year students in the program. This prevented collecting data from 4^{th} year level at MAKÜ. Table 4.2 showed year level in EME program distribution of each university too.

Table 4.2: University-Gender and Year Level Distributions of the Participants

	Female	Male	3rd Year	4th Year
	n (%)	n (%)	n (%)	n (%)
METU	42 (75.0)	14 (25.0)	32 (57.1)	24 (42.9)
Hacettepe	67 (72.8)	26 (27.2)	51 (52.0)	41 (48.0)
Başkent	25 (71.4)	10 (28.6)	17 (48.5)	18 (51.5)
Abant İzzet Baysal	13 (56.7)	9 (43.3)	19 (86.3)	3 (13.7)
Dokuz Eylül	51 (73.9)	18 (26.1)	37 (53.6)	32 (46.4)
Balıkesir	91 (59.0)	63 (41.0)	58 (37.6)	96 (62.4)
Ondokuz Mayıs	65 (73.0)	24 (27.0)	54 (60.6)	35 (39.4)
MAKÜ	10 (66.6)	5 (33.4)	15 (100)	0 (0)
Gaziantep	14 (60.8)	9 (39.2)	13 (56.5)	10 (43.5)
Yüzüncü Yıl	21 (72.4)	8 (27.6)	22 (75.8)	7 (24.2)
Total	398(68.2)	186(31.8)	303(51.9)	281(48.1)

4.2 Analysis for Research Questions

In this part of the chapter, each research question's analysis results are reported. For each analysis, assumptions of tests and process of analysis are stated separately.

4.2.1 Validity and Reliability of the MRBS

Validity and reliability of MRBS analysis results are given in this part in detail.

4.2.1.1 Validity of MRBS

The main research question in this study was if the mathematics related beliefs scale (MRBS) was a valid and reliable scale for understanding preservice elementary mathematics teachers' mathematics related beliefs.

Educationalists have attempted to systematize a framework for teachers' mathematical belief systems into smaller sub–domains. Most authors agree with a system mainly consisting of beliefs about (a) what mathematics is, (b) how mathematics teaching and learning actually occurs, and (c) how mathematics teaching and learning should occur ideally (Ernest, 1989; Thompson, 1992). The MRBS was also prepared according to those sub-domains. Belief statements were basically adapted from Thompson (1991), Lindgren (1996) and Ernest's(1989) frameworks and the literature and these statements reflected constructivist and traditional views of mathematics and mathematics teaching and learning. MRBS and exploratory factor analysis was run to investigate the sub-domains of MRBS.

Before conducting factor analysis, data cleaning procedures were applied. Missing values of each item were measured as less than 1 percent for each item and the total missing value of the data was less than 10 percent. Therefore, researcher did not replace missing values (Pallant, 2005).

Factor analysis was a method which explained variability between observed variables (Bryant & Yarnold, 1994). Factor analysis mainly involves three steps; (1) assessment of the data, (2) factor extraction, and (3) factor rotation. For the first step, assessment of the suitability of the data for factor analysis should be controlled. This step could be considered as checking assumptions of factor analysis because assumption check ensured how data was suitable for factor analysis. Before conducting factor analysis, researcher checked assumptions of the factor as presented below

4.2.1.1.1 Assessment of the Data

There were four main assumptions for factor analysis; (a) sample size, (b) factorability of correlational matrix, (c) linearity, and (d) outliers among cases. Assessment of the data could only be provided through checking these assumptions.

4.2.1.1.1.1 Sample Size

For conducting factor analysis, sample size was an important assumption. Ideally, more than 150 participants were suggested for factor analysis. “There was no common agreement on the needed sample size for factor analysis but researchers recommend that the larger the sample size, the better results for factor analysis” (Pallant, 2006, p.179). Considering the number of items in the instrument and Nunnaly’s (1978) recommendation that 10 cases were needed for each item for the factor analysis, more than 320 participants were required for the study (as cited in

Fraenkel & Wallen, 2006). Based on this estimation, since 584 preservice mathematics teachers were participating in the study, sample size was large enough to conduct factor analysis.

4.2.1.1.1.2 Factorability of the Correlation Matrix

Another main assumption for factor analysis was factorability of data. This assumption provided researcher to understand how collected data was suitable to conduct factor analysis. For understanding factorability of the correlation matrix; correlation matrix, Bartlett's test of sphericity, and Kaiser-Meyer-Olkin value should be identified (Pallant, 2005). Factorability issue to understand the suitability of the data for factor analysis was the strength of relationship among items. Tabachnick and Fidell (2001) recommended an inspection of the correlation matrix for evidence of coefficients greater than .3. Since there were more correlation coefficients of .3 and above, data was suitable for factor analysis. Bartlett's Test of Sphericity (Bartlett, 1954), and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser, 1970; 1974) were other test's for understanding the factorability of the data (Pallant, 2005). The Bartlett's Test of Sphericity should be significant ($p<.05$) for the factor analysis to be considered appropriate. The KMO index ranges from 0 to 1, with .6 suggested as the minimum value for a good factor analysis (Tabachnick & Fidell, 2001). Since the Bartlett's Test of Sphericity ($.00 < .05$) and KMO ($.917 > .600$) measures were found as suggested, data's was determined as strong to run factor analysis. Second important assumption of factor analysis was ensured.

4.2.1.1.1.3 Linearity

The third assumption of factor analysis was linearity. Since the factor analysis was a kind of correlation analysis, it was assumed there was a linear correlation between variables (Pallant, 2005). Pallant (2005) did not suggest checking scatterplots for each variable because this method was not practical. Instead of this method, Tabachnick and Fidell (2001) offered "spot check of some combinations" (as cited in Pallant, 2005, p.178). Moreover; Tabachnick and Fidell (2001) highlighted that if the first assumption was provided, there would be a curvilinear relationship between variables because large number of simple size would ensure curvilinear relationship. Therefore; linearity assumption was also ensured.

4.2.1.1.1.4 Outliers among Cases

Last assumption of factor analysis was outliers among cases. Since factor analysis was a kind of correlation study and determined relationships between variables, it was a sensitive analysis for outliers (Pallant, 2005). The MRBS was a 5 point Likert type scale and it was implemented on participants through optical form. The maximum value for items was 5 and minimum value for items was 1; therefore, values should be between these two. During the data cleaning procedure, it was checked whether there was an outlier and it was determined that there was no outliers in the study.

The check for assumptions for conducting factor analysis showed that data was suitable for factor analysis. Therefore, first step of factor analysis was successfully ensured.

4.2.1.1.2 Factor Extraction

The second step of the factor analysis was factor extraction. To determine the smallest number of factors that could be used to best represent the interrelations among the items, three basic methods could be used; (a) Kaiser's criterions, (b) Catell's scree test, and (c) parallel analysis (Pallant, 2005). Results of these tests are presented below.

4.2.1.1.2.1 Kaiser's Criterions Test

Firstly, Kaiser's criterions test was checked to extract the number of factors of the MRBS. Depending on Kaiser's criterion, number of factors was determined which had eigenvalue of 1 or above (Pallant, 2005). For understanding components which had eigenvalue over one, Total Variance Explained table was examined. Table showed that, there were 7 components with eigenvalue above 1 for the current study. These seven components explained the total of 52.49 % variance. Since the number of components was excessive, researcher preferred to check screeplot to extract factors (Total Variance Explained Table is given in Appendix F).

4.2.1.1.2.2 Catell's Scree Test

Secondly, Catell's scree test was done to determine number of factors. Catell (1966) suggested that "retaining all factors above the elbow or the break in the plot, as these factors contribute the most to the explanation of the variance in the data" (as cited Pallent, 2005, p.175). In this study, there was a sharp break between the second and third components (see Figure 4.1), which addressed that Component 1 and Component 2 explained most of the of the variance. Pallant (2005) highlighted that Kaiser Criterion test usually would find too many components; therefore, it would be essential to look at screeplot during factor extraction. Consequently, Catell's scree test results were not completely parallel to the Kaiser's criterion test results. Screeplot showed that there were not seven components, there were only two factors for the MRBS.

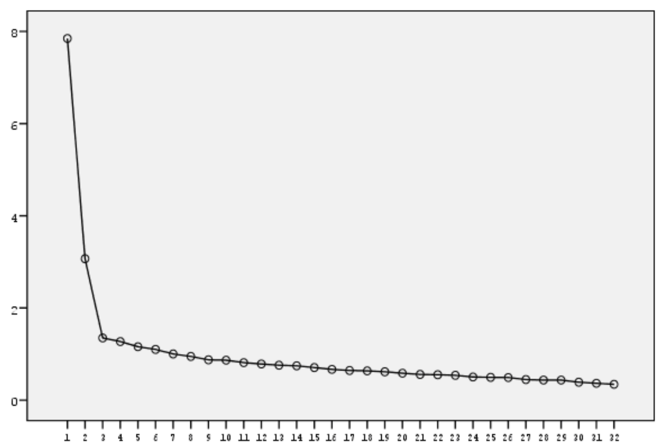

Figure 4.1: Screeplot of Eigenvalues of the Study

4.2.1.1.2.3 Parallel Analysis

Thirdly, parallel analysis can be used to determine the number of factors. For this analysis, Monte Carlo PCA for Parallel Analysis developed by Watkins (2000) was used since it “generated 100 sets of random data of the same size as real data file (32 variables x 584 cases)” (Pallant, 2005, p 183). To understand the number of factors, factors with eigenvalue over 1 in Total Variance Explained Table and Monte Carlo PCA Parallel Analysis results should be compared. It was stated by Pallant (2005) that if the Kaiser’s criterion value of a factor was larger than parallel analysis, it should be retained but if it was less, then it should be rejected. Table 4.3 showed this comparison of the two tests’ eigenvalues.

Table 4.3: Comparison of Eigenvalues by PCA and Parallel Analysis

Component Number	Actual eigenvalue from PCA	Criterion value from parallel analysis	Decision
1	7,8470	1,4632	Retain
2	3,0690	1,4035	Retain
3	1,3500	1,3580	Reject
4	1,2710	1,3195	Reject
5	1,1590	1,2807	Reject
6	1,1000	1,2221	Reject
7	1,0020	1,1932	Reject

Results of the parallel analysis showed that there were two factors for the MRBS. Results were parallel to the Caiser's scree test result; therefore, two factors for the MRBS were extracted.

4.2.1.1.3 Factor Interpretation

Once the number of factors had been determined, the next step was to try to interpret them. To assist in this process, the factors were rotated. There were two main approaches to rotation, resulting in either orthogonal (uncorrelated) or oblique (correlated) factor solutions. According to Tabachnick and Fidell (2001, as cited Pallant, 2006), "orthogonal rotations result in solutions that are easier to interpret and report" (p.183). As a result, in this study researcher used one of the orthogonal rotations, varimax rotation, which attempted to minimize the number of variables that would have high loadings on each factor. For factor rotation, factor analysis was run again. However, this time the number of factors was determined as two and varimax method was used for rotation. After analysis run, rotated component matrix table was interpreted.

Once the loadings used for interpretation were significant, then the focus would be on which loadings were large enough to be practically significant. As a result, Stevens (2002) suggested "using loadings which are about .40 or greater can be interpreted" (p. 394). Analysis showed that there were only two items loaded under values .40 (.388, 371); however, they were very close to it. Therefore, depending on factor loadings, all items were grouped and labeled by the factor analysis, but naming and interpreting these groups depended on researcher.

Prior to naming and interpreting components, researcher measured the correlation between two components. Pallant (2005) addressed that the component correlation matrix would show how strong the relationship between two factors. This would provide information for deciding how reasonable it would be to assume no relationship between the two components, or whether there would be a need to use more complex Oblimin rotation. In this case correlation value was reported as .055 which was quite a low correlation. Pallant (2005) stated that if correlation value is above .3, there means a discrepancies and more complex analysis needed. Since correlation value is .055 for this study, Varimax and Oblimin results were parallel to each other.

As cited before, analysis showed that the MRBS had two components. After the principal component analysis (PCA) was repeated with varimax rotation method, total variance explained (34,110%) did not change. Now, Component 1 explained the 23.707% and Component 2 explained the 10.403% of the total variance. 23 items (1, 2, 5, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32) were loaded under the Component 1, whereas 9 items (3, 4, 6, 7, 8, 9, 10, 21, 23) were loaded under Component 2. Pallant (2005) highlighted that items should be loaded only on one component, if one item had loading on more than one component after rotation, it could be problematic. It was suggested to remove these items from scale. There were some items (6, 7, 10, 13, 20, 30) loading on two components. Therefore, PCA was repeated by removing these items. Item loadings did not change and same items were loaded under the same components. This time, the two components explained the total of 35.72 percent of the variance, with Component 1 contributing 26.27% and Component 2 contributing 9.45%. The components were interpreted and named without these items.

Table 4.4: Item Distribution for Component 1

Factor Name	Variables	Factor Loading
Constructivist Beliefs	Students should participate in the building process of mathematical concepts for understanding them.	.441
	It is important for mathematics education to provide active discussion environment for students.	.536
	Purpose of teaching mathematics is developing students' reasoning by researching mathematical concepts.	.572
	During mathematics lessons one should emphasize the importance of mathematical thinking.	.618
	The teacher should let the students use many learning games while teaching mathematics.	.588
	One should ask non-routine problems as often as possible while teaching mathematics.	.421
	In the mathematics lesson, any concept can be taught by creating a problem situation.	.543
	Mathematics is not complete.	.548
	The pupils should have a possibility to formulate problems by themselves and then solve them.	.652

Table 4.4: Item Distribution for Component 1 (cont'd)

Factor Name	Variables	Factor Loading
	Visual and concrete representations and materials should be used as often as possible while teaching mathematics.	.597
	Students should have opportunity to reach same result with different ways.	.652
	Proof and generalization are important parts of mathematics teaching.	.477
	Goal of using visual and concrete representations and materials is to develop positive attitude toward mathematics.	- .490
	Students should put effort to understand the justification of the mathematical procedures.	.606
	Ideas developed by students should be taken into consideration while teaching mathematics.	.673
	Students should be encouraged to work together while teaching mathematics.	.647
	One should give importance on usage of technology while teaching mathematics.	.594
	One should allow for problems which students can implement their learning besides calculation while teaching mathematics.	.663
	Students should like their mathematics teacher in order to like mathematics.	- .403
	Mathematics is important because it is related to other courses.	.503
	Mathematical knowledge is the result of the learner interpreting and organizing the information gained from experiences.	.506
	Purpose of the teaching mathematics is to prepare students to life.	.388
	In mathematics education, materials and visual representations are not effective for developing mathematical concepts.	.457

Similar to Component 1, item distribution for Component 2 was as follows:

Table 4.5: Item Distribution for Component 2

Factor Name	Variables	Factor Loading
Traditional Beliefs	Mathematics is basically the usage of arithmetic skills in daily life.	.371
	Mathematical knowledge is composed of facts, rules and procedures.	.483
	While teaching mathematics; for developing students' arithmetic skills, one should memorize rules without mentioning relationships among them.	.478
	Textbook should be followed without considering relevancy of the concepts while teaching mathematics.	.514
	Teacher's role is to demonstrate the procedures as mathematical knowledge.	.565
	Students should solve many problems to learn mathematics.	.650
	In mathematics; if information is explained by the teacher or the book, it is absolutely right.	.582
	In mathematics education, teacher's solution steps should be followed step by step at the end of the subject.	.609
	Purpose of mathematics teaching is reaching correct answer while solving problems through using ways that are taught during the lesson.	.630

After items were grouped under the Component 1 and Component 2, researcher analyzed and interpreted these components. It was clearly distinguished that items loading under Component 1 were generally related with mathematics teaching and learning opportunities and also instructional strategies such as how mathematics should be taught, which strategies should be used to teach mathematics, and which opportunities students should have in order to learn mathematics, which were parallel to the constructivist view. Therefore Component 1 was named as "Constructivist Beliefs."

The second component of the MRBS generally consisted of items about traditional mathematics teaching beliefs and traditional beliefs about the nature of mathematics. Depending on these results, Component 2 was named as "Traditional Beliefs."

4.2.1.2 Reliability of MRBS

Internal Consistency Reliability method was applied to measure the reliability of the scale. "The reliability of the instrument is decided by estimating how well the items that reflect the same construct yield similar results" (Fraenkel & Wallen, 2006, p.157). Cronbach's Alpha measure was used to estimate reliability of the MRSB and Cronbach's alpha value was calculated as .824 which was higher than the suggested value of 0.7 (Pallant, 2005). Following to measuring reliability of MRBS, researcher measures Cronbach's alpha levels for each component. For the

Component 1 and Component 2, .835 and .734 measures were calculated respectively as reliability scores which were higher than suggested.

Therefore, it could be stated that the MRBS and its components would reliably measure preservice mathematics teachers' mathematics related beliefs.

4.2.1.3 Summary of PCA

The 32 items of the Mathematics Related Belief Scale (MRBS) were exposed to the Principal Components Analysis (PCA) by SPSS 15. Before applying PCA, the suitability of data for factor analysis was checked and assumptions of PCA were examined. Correlation matrix demonstrated that there were many coefficients of .3 and above. The Kaiser-Meyer-Oklin value was .917, above the recommended value of .6 (Kaiser, 1970, 1974) and the Barlett's Test of Sphericity (Bartlett, 1954) was significance and these values were supporting the factorability of the data.

PCA exposed that there were seven components of MRBS with eigenvalues over 1. However, Catell's scree test and parallel tests resulted in two components. Screeplot showed a clear break between the second and third components. Moreover, Parallel Analysis, which revealed only two components with eigenvalues more than the matching criterion values for a randomly generated data matrix of the same size. For interpreting these two components, Varimax rotation was applied. The rotated component matrix showed strong loadings on only one component.

The two component solution explained a total of 34.110% of the variance, with Component 1 contributing 23.707% and Component 2 contributing 10.403%. The interpretation of two components did not directly correspond to the theoretical framework. Components of MRBS were appeared as Constructivist Beliefs and Traditional Beliefs. As cited before, combination of three teacher belief models were taken as the theoretical framework for this study. They leveled beliefs into three parts and in each level there are belief statements about nature of mathematics, learning mathematics, and teaching mathematics although there was no direct distribution as nature, learning, and teaching by the authors. The results showed that preservice teachers considered the belief statements rather in relation to the constructivist and traditional approach to mathematics.

4.2.2 Mathematics Related Beliefs of Turkish Preservice Mathematics Teachers

In order to determine preservice mathematics teachers' mathematical related beliefs in Turkey, descriptive statistic of mean scores for each item was examined. The mean scores of each item were interpreted as beliefs of the preservice teachers. Depending on mean scores, Turkish preservice mathematics teachers' mathematics related beliefs were listed according to (a) Constructivist Beliefs and

(b) Traditional Beliefs. Before giving belief scores and interpretation of each component, preservice teachers' general mean scores for the instrument was calculated.

Mean score was measured as 3.5 for the whole scale which meant that participating preservice mathematics teachers slightly agreed on belief statements.

4.2.2.1 Constructivist Beliefs

For Component 1 the general mean score was measured as 3.97 which meant that participating preservice mathematics teachers agreed with the items of the MRBS. Item mean distribution is shown in Table 4.6

Table 4.6: Item Mean Distribution for Component 1

Variables	Means
Students should participate in building process of mathematical concepts for understanding them.	4,21
It is important for mathematics education to provide active discussion environment for students.	4,25
Purpose of teaching mathematics is developing students' reasoning by researching mathematical concepts.	4,13
During mathematics lessons one should emphasize the importance of mathematical thinking.	4,36
The teacher should let the students use many learning games while mathematics teaching.	4,31
One should ask non-routine problems as often as possible while mathematics teaching.	3,80
In the mathematics lesson, any concept can be taught by creating problem situation.	4,07

Table 4.6: Item Mean Distribution for Component 1 (cont'd)

Variables	Means
Mathematics is not complete.	4,23
The pupils should have a possibility to formulate problems by themselves and then solve them.	4,31
Visual and concrete representations and materials should be used as often as possible while mathematics teaching.	4,32
Students should have opportunity to reach same result with different ways.	4,47
Proof and generalization are important part of mathematics teaching.	4,02
Goal of using visual and concrete representations and materials is to develop positive attitude toward mathematics.	2,13
Students should put effort to understand the justification of the mathematical procedures.	3,43
Ideas developed by students should be take into consideration While mathematics teaching.	4,32
Students should be encouraged to work together while teaching mathematics.	4,21
One should give importance on usage of technology while teaching mathematics.	4,32
One should allow for problems which students can implement their learning beside calculation while mathematics teaching,	4,12
For loving mathematics, students should love their teacher.	1,78
Mathematics is important because it is related to other courses.	4,01
Mathematical knowledge is the result of the learner interpreting and organizing the information gained from experiences.	4,77
Purpose of the teaching mathematics is to prepare students to life.	3,67
In mathematics education, materials and visual representations are not effective for developing mathematical concepts.	4,11

Participants agreed that students should participate in the building process of mathematical concepts for understanding them, and it was important for mathematics education to provide active discussion environment for students. They addressed the purpose of teaching mathematics as developing students' understanding by researching mathematical concepts. Moreover, they agreed with the belief statement about the purpose of mathematics teaching as reaching correct answer while solving problems by using ways that were taught during the lesson. However, mathematics was described as an unfinished product.

About the problem solving beliefs, they agreed that while teaching mathematics, one should ask non-routine problems as often as possible and also in mathematics lesson, one concept could be taught by creating problem situations. Moreover, pupils should have a possibility to formulate problems by themselves and then solve them. Turkish preservice mathematics teachers agreed with the belief that students should have the opportunity to reach same result in different ways and ideas developed by students should be take into consideration. Group work seemed to be important for preservice teachers for mathematics teaching. They agreed that during mathematics lessons one should emphasize the importance of mathematical thinking and students should put effort to understand the justification of the mathematical procedures.

Participants addressed that visual and concrete representations and materials should be used as often as possible to develop positive attitude towards mathematics. The use of technology and learning games should be emphasized during mathematics teaching. They believed that proof and generalization was an important part of mathematics teaching.

Mathematical knowledge was seen as the result of the learner interpreting and organizing the information gained from experiences and since mathematics was related to other courses, it was important. Participants did not agree with the idea that students would like mathematics if they liked their mathematics teacher.

4.2.2.2 Traditional Beliefs

For Component 2, the general mean score was measured as 3.2 which meant that Turkish preservice teachers had neutral traditional beliefs. Table 4.7 shows the item mean distribution of Component 2.

Turkish preservice teachers believed that mathematics was basically the usage of arithmetic skills in daily life. For developing these arithmetic skills, students should memorize rules without mentioning relationships among them. Preservice teachers did no seem to believe that mathematical knowledge was composed of facts, rules, and procedures.

In mathematics education, participants believed that teacher’s solution steps should be followed step by step during the mathematics lesson. They did not believe that the mathematics explained by the teacher or the book was absolutely right and textbook should be followed without considering relevancy of the concepts. Preservice teachers' beliefs about teacher's role were that teachers should demonstrate the procedures as mathematical knowledge. However, they were neutral about the idea that students should solve many problems to learn mathematics.

Table 4.7: Item Mean Distribution for Component 2

Variables	Mean
Mathematics is basically the usage of arithmetic skills in daily life.	2,33
Mathematical knowledge is composed of facts, rules and procedures.	2,63
While teaching mathematics; for developing students' arithmetic skills, one should memorized rules without mentioning relationships among them.	4,33
While teaching mathematics, textbook should be followed without considering relevancy of the concepts.	4,04
Teacher's role is to demonstrate the procedures as mathematical knowledge.	3,16
Students should solve many problems to learn mathematics	2,63
In mathematics; if information is explained by teacher or book, it is absolutely right.	3,93
In mathematics education, teacher's solution steps should be followed step by step at the end of the subject.	2,99
Purpose of mathematics teaching, reaching correct answer while solving problems with using ways that taught during the lesson.	3,13

In summary, the result of the factor analysis process revealed two components as Constructivist Beliefs (Component 1) and Traditional Beliefs (Component 2). Table 4.8 shows the reversed items, number of component, mean, factor loading, and Cronbach's Alpha values if item deleted for each item.

Table 4.8: MRBS's Item Means, Components, Factor Loadings and Cronbach's Alpha values if item is deleted

Number of items	Number of Component	Mean	Factor Loading	Cronbach's Alpha if item deleted
Item 1	1	4.21	.441	.817
Item 2	1	4.25	.536	.813
Item 3*	2	2.33	.371	.835
Item 4 *	2	2.63	.483	.829
Item 5	1	4.13	.572	.818
Item 6 *	2	4.33	.478	.812
Item 7 *	2	4.04	.514	.814
Item 8 *	2	3.16	.565	.824
Item 9 *	2	2.63	.650	.823
Item 10 *	2	3.93	.582	.816
Item 11	1	4.36	.618	.814
Item 12	1	4.31	.588	.816
Item 13	1	3.80	.421	.825
Item 14	1	4.07	.543	.815
Item 15	1	4.23	.548	.818
Item 16	1	4.31	.652	.812
Item 17	1	4.32	.597	.816
Item 18	1	4.47	.652	.813
Item 19	1	4.02	.477	.819
Item 20 *	1	2.13	-.490	.838
Item 21 *	2	2.99	.609	.824
Item 22	1	3.43	.606	.816
Item 23 *	2	3.13	.630	.820
Item 24	1	4.32	.673	.812

Table 4.8: MRBS's Item Means, Components, Factor Loadings and Cronbach's Alpha values if item is deleted (cont'd)

Number of items	Number of Component	Mean	Factor Loading	Cronbach's Alpha if item deleted
Item 25	1	4.21	.647	.817
Item 26	1	4.32	.594	.815
Item 27	1	4.12	.663	.815
Item 28 *	1	1.78	-.403	.839
Item 29	1	4.01	.503	.820
Item 30	1	4.77	.506	.822
Item 31	1	3.67	.388	.814
Item 32 *	1	4.11	.457	.815

4.2.3 Gender and Grade Level Differences in Preservice Mathematics Teachers' Beliefs

The impact of the gender and year level on preservice mathematics teachers' beliefs was also investigated in this study through the MRBS. The information about participants' gender and year levels collected through MRBS provided the opportunity to compare participants' mathematics related beliefs in terms of these variables. For testing the impact of the gender and year level on mathematics related beliefs, two-way between groups Analysis of Variance (ANOVA) was used since two-way ANOVA helped to explore the main effect of each independent variable on the dependent variable. Moreover, it provided the evidence for whether there was an interaction effect or not. For this case, effect of gender and year level for each component was tested. For testing the gender and year level, dependent and independent variables were identified. The dependent variable was preservice teachers' belief scores' mean and the independent variables were gender and year level of participants. Mean belief scores for Component1 and Component 2 were measured separately. The hypotheses tested for each component were as follows:

H_1: There is a significant effect of gender and year level on preservice mathematics teachers' constructivist mathematics related beliefs.

H_1: There is a significant effect of gender and year level on preservice mathematics teachers' traditional mathematics related beliefs.

Multivariate Analysis of Variance (MANOVA) analysis was not employed for this study because assumptions of MANOVA could not be ensured. Prior to conduct two-way ANOVA, assumptions of the test should be checked.

4.2.3.1 Assumptions of ANOVA

There are three main assumptions: (a) independence of observation, (b) normality, and (c) homogeneity of variance for two-way between groups ANOVA. Each assumption was checked for both Component 1 and Component 2.

4.2.3.1.1 Independent Observation

As Pallant (2005) stated, individual's score should not be influenced by any other individuals. In this study, MRBS was administered to preservice mathematics teachers at ten different universities, in different year levels, at different cities. Participants could not complete MRBS at the same time; however, participants could not affect each other because they were in different cities. The scale was not implemented by the researcher in most of the universities; however, the implementers were informed in detail about the implementation. It was request by implementers to remind participants that each person should completed scale by oneself. Each university and each class was independent from each other; however, students from same class were educated by same program and same instructors. In other words, their academic development process was shaped by the same factors; therefore, they were affected by the same factors. This situation limited independent observation assumption.

4.2.3.1.2 Normality

Normality was the second basic assumption of ANOVA. Normal is described as "a symmetrical, bell shaped curve, which has the greatest frequency in the middle and relatively smaller frequencies toward either extreme" (Gravetter & Wallnau, 2000, p.52). Pallant (2005) recommended three basic methods to assess normality; (a) skewness and kurtosis, (b) histograms & normality plots, and (c) test of normality.

The term skewness was described as “the symmetry of the distribution” (Pallant, 2005, p.53). In other words, it could be considered as a measure of whether distribution would be peak in the middle (Gravetter & Wallnau, 2000). The term kurtosis was described as “the peakedness of the distribution” (Pallant, 2005, p.53). It was suggested that if a distribution was normal, skewness and kurtosis values must be between -1 and +1, but values between -2 and + 2 could also be acceptable for normal distribution (Pallant, 2005). For perfect normality, values should be around zero (Pallant, 2005). Skewness and kurtosis values of preservice teachers' belief values means were examined in terms of gender and year level. Skewness and kurtosis values are given in Table 4.9 for each component.

Table 4.9: Skewness and Kurtosis Values of Mean Belief Scores of Gender and Year Level

		Skewness	Kurtosis
Component 1	Female	-1.796	7,305
	Male	-0.685	0.872
	3rd year	-1.247	3.750
	4th year	-1.589	6.034
Component 2	Female	-.088	-.496
	Male	-.134	.300
	3rd year	-.345	-.047
	4th year	.184	-.308

As confirmed in Table 4.9; participants' mean belief scores' skewness and kurtosis values in terms of gender and year level were almost around 0, even there were some kurtosis values over 2. However; these values could be tolerated by the power of other normality tests. Both female and male participants and 3rd and 4th year participants had skewness values under 0, which meant that there was a negatively skewed distribution. Moreover, almost all kurtosis values were over the value +2. This indicated that preservice teachers' mean belief scores did not explain perfect normal distribution. Pallant (2005) indicated that in the large number of groups, skewness and kurtosis values would not be enough to determine whether the data was normal or not; therefore, histograms and Normal Q-Q plots could be used to determine the normality. All histograms and Normal Q-Q plots are given in Appendix G. Histograms for the female and male participants' scores did not demonstrate a normal distribution; however, histograms for 3rd year and 4th year participants were closer to normal distribution. While the Normal Q-Q plots were examined among the preservice teachers' mean scores in terms of gender and year level, plots had reasonably straight lines.

Lastly, Test of Normality tables were examined to determine whether data was distributed normally. Kolmogorov-Smirnov statistics results showed the significant values for each independent variable. It was advised that significant level must be less than .05 for normal distribution. For the Component 1 significance level of female ($.00 < .05$), third year ($.00 < .05$), and fourth year ($.00 < .05$) participants were lower than the significance level of .05. Only males' significance level ($.09 > 0.05$) was quite lower than .05 for Component 1; however, normality was provided by skewness value for males in Component 1. For the Component 2 significance level of female (.012< .05), male (.043 <.05), third year (.001<.05), and fourth year (.005<.05) participants were lower than the significance level of .05. Therefore, the data could be admitted as normally distributed depending on the test of normality results.

4.2.3.1.3 Homogeneity of Variance

Third assumption of the two-way ANOVA was homogeneity of variance. Homogeneity of variance was described as the equalness of the variance within each of the population (Pallant 2005). In order to determine whether homogeneity of variance was ensured, Levene's Test of Equality was examined. Pallant (2005) stated that significant result less than .05 would address that variance of the dependent variable across the groups was not equal. As shown in Table 4.10, significance level of MRBS for each component was given as 0.108 and 0.135 separately which were greater than the significance value 0.05. Therefore, homogeneity of variance assumption was not violated.

Table 4.10: Levene's Test of Equality of Error Variances

	F	df1	df2	Sig
Component 1	2.036	3	527	.108
Component 2	1.859	3	554	.135

Consequently, two main assumptions of the two-way between groups ANOVA was checked and assumptions were satisfied.

4.2.3.2 Descriptive Statistics of ANOVA

Descriptive statistics of ANOVA explained the mean differences in terms of gender and year level. For Constructivist Beliefs, the summary of the descriptive statistics of ANOVA is given in Table 4.11. When the mean belief scores of males and females were examined in terms of year level, for the female students, 3rd year students' mean belief score (4.0428) was higher. Whereas, for the male students, 4th year students' mean belief score (3.9408) was higher.

Table 4.11: Belief Scores with Respect to Gender and Year Level for Component 1

gender	year	Mean	Std. Deviation	N
female	3rd year	4.0428	.35016	188
	4th year	3.9603	.42919	174
	Total	4.0031	.39178	362
male	3rd year	3.9036	.44095	83
	4th year	3.9408	.33803	86
	Total	3.9226	.39123	169
Total	3rd year	4.0002	.38484	271
	4th year	3.9538	.40078	260
	Total	3.9775	.39304	531

For Traditional Beliefs, the summary of the descriptive statistics of ANOVA is given in Table 4.12. When the mean belief scores of males and females were examined in terms of year level, for the female students, 3rd year students' mean belief score (3.3557) was higher. Whereas, for the male students, 4th year students' mean belief score (3.1768) was higher.

Table 4.12: Belief Scores with Respect to Gender and Year Level for Component 2

gender	year	Mean	Std. Deviation	N
female	3rd year	3.3557	.57247	204
	4th year	3.1587	.61364	182
	Total	3.2628	.599960	386
male	3rd year	3.1257	.63882	84
	4th year	3.1768	.50977	88
	Total	3.1518	.57528	172
Total	3rd year	3.2886	.600066	288
	4th year	3.1646	.58093	270
	Total	3.2286	.59391	558

4.2.3.3 Inferential Statistics of ANOVA

For determining the impact of gender and year level on preservice mathematics teachers' belief scores for Component 1, two-way ANOVA was conducted at the $p<0.05$ level of significance. Table 4.13 presented results of the tests. As presented on the table, gender had a significant effect [F (1, 527) = 4.742, p = 0.030] on preservice mathematics teachers' constructivist beliefs, whereas year level did not have significant effect [F (1, 527) = .387, p = 0.534] on preservice mathematics teachers' constructivist belief scores.

Table 4.13: Two-Way ANOVA on the Subject of Gender and Year Level for Component 1

	Type III sum of square	df	Mean Squares	F	Sig.	Partial Eta Squared	Observed power
Gender	,724	1	.724	4.742	.030	,.009	.585
Year Level	,059	1	.059	.387	.534	.001	.095
Gender-Year Level	.413	1	.413	2.704	.101	.005	.375
Error	80.451	527	.153				
Total	8482.490	531					
Corrected total	81.873	530					

Computing using alpha 0.05

Gender-year level interaction graph for Component1 was shown in Figure 4.2. It was very clear from the Estimated Marginal Means of Component 1 that there was a quite small difference in female (4.04) and male (3.90) mean scores for the 3rd year preservice teachers. The mean difference became closer for the 4th year preservice teachers as for females 3.96 and for males 3.94.

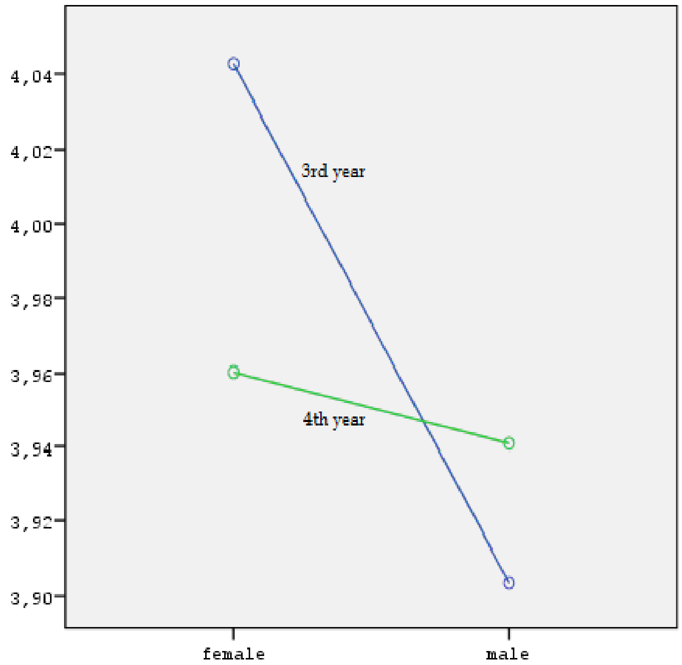

Figure 4.2: Estimated Marginal Means of Component 1

For determining the impact of gender and year level on preservice mathematics teachers' belief scores for Component 2, two-way ANOVA was conducted at the $p<0.05$ level of significance. Table 4.14 presented results of the tests. As presented on the table, gender had a significant effect [F (1, 527) = 3.868, p = 0.05] on preservice mathematics teachers' traditional beliefs, whereas year level did not have significant effect [F (1, 527) = 1,831, p = 0.177] on preservice mathematics teachers' traditional belief scores. Differing from the first component, gender-year level interaction had a significant effect [F (1, 527) = 5.296, p = 0.022] on preservice mathematics teachers' traditional beliefs. Thus, there was a significant effect of year level for female and male students' traditional beliefs.

Table 4.14: Two-Way ANOVA on the Subject of Gender and Year Level for Component 2

	Type III sum of square	df	Mean Squares	F	Sig.	Partial Eta Squared	Observed power
Gender	,1.335	1	1.335	3.868	.050	.007	.501
Year Level	.632	1	.632	1.831	.177	,003	.272
Gender-Year Level	1.828	1	1.828	5.296	.022	.009	.632
Error	191.163	554	.345				
Total	6012.963	558					
Corrected total	196.471	557					

Computing using alpha 0.05

Similar to results of Component 1, there was a quite small mean difference in female (3.35) and male (3.12) beliefs score of 3rd year students for Component 2. The mean difference became closer for the 4th year preservice teachers as for females 3.15 and for males 3.17.

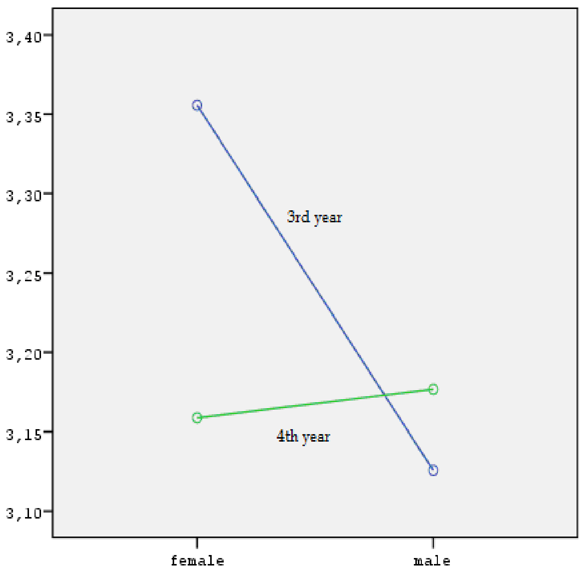

Figure 4.3: Estimated Marginal Means of Component 2

For checking the correctness of significances, Pallant (2005) recommended to check the effect size of the variables. Checking eta squared values was the most common used method for checking the effect size (Pallant, 2005). The term partial eta squared value was described as “the proportion of variance of the dependent variable that is related to a particular main or interaction source, excluding the other main and interaction sources” (Green, Salkind & Akey, 2000, p.169). The effect size values were defined as small 0.01, medium 0.06, and large 0.14 (Cohen & Cohen, 1983).

For Component 1, as presented in Table 4.13, partial eta square values of gender, year level, and gender-year level interaction were 0.009, 0.001, and 0.005 respectively. Partial eta square values showed that gender, year level and gender-year level interaction had small effect on constructivist belief scores.

Observed power values showed the “probability of reaching correct decision” (Gravetter & Wallnau, 2003, p.250). Table 4.13 showed that power of gender was 0.585 which meant that the decision of rejecting null hypothesis was 58 % and gender had a weak significant effect on preservice mathematics teachers’ constructivist belief scores. Similarly, power of gender-year level interaction was 0.375 which meant that the decision of rejecting null hypothesis was 37% and gender-year level interaction had a weak significant effect on preservice mathematics teachers’ constructivist belief scores.

For Component 2, as presented in Table 4.14, partial eta squared values of gender, year level and gender-year level interaction were 0.007, 0.003, and 0.009 respectively. Partial eta square values showed that gender, year level, and gender-year level interaction had small effect on traditional beliefs scores. Table 4.13 showed that power of gender was 0.501 which meant that the decision of rejecting null hypothesis was 50 % and gender had a weak significant effect on preservice mathematics teachers' traditional belief scores. Similarly, power of gender-year level interaction was 0.632 which meant that the decision of rejecting null hypothesis was 63% and gender-year level interaction had a weak significant effect on preservice mathematics teachers' belief scores. Results addressed that gender had an effect and year level did not have significant effect on constructivist and traditional belief scores.

CHAPTER 5

DISCUSSION AND CONCLUSION

This chapter presents a brief summary of the major findings and their discussions. Finally, implications and recommendations are shared respectively.

5.1 Summary of the Study

Research on teachers' beliefs has been regarded as an essential subject for educational research because it has been often claimed that beliefs influenced practice (Raymond, 1997; Vacc, 1999). Studies have also confirmed that teachers' beliefs have a considerable effect on student beliefs Chapman, 2001; (Lester & Garofalo, 1987). Considering the relation between teachers' beliefs, their practices, and their students' beliefs, several studies have examined preservice teachers' beliefs and they have concluded that preservice teachers' beliefs tended to influence their future classroom practice (Pajares, 1992; Thompson, 1992).

In this study, researcher developed a valid and reliable Mathematics Related Belief Scale to measure Turkish preservice mathematics teachers' mathematics related beliefs. Preparation of MRBS was based on the theoretical framework which was a combination of three belief models from the literature. Items of MRBS were written according to these models. Afterwards, researcher developed MRBS by the help of expert opinions and pilot study. The final version of MRBS was implemented to 584 preservice teachers from ten different universities of Turkey. Data was analyzed to determine the sub-domains of MRBS and it was concluded that MRBS had two sub-domains. After providing validity and reliability of MRBS, researcher explored the effect of gender and year level in EME program on preservice elementary mathematics teachers' mathematics related beliefs. For this purpose two-way between groups ANOVA method was used for each component separately. Results of the analysis showed that for both components, gender had a significant effect on preservice elementary mathematics teachers' mathematics related beliefs, whereas year level did not have. Gender-year level interaction did not also have a significant effect on preservice teachers' mathematics related beliefs. For each component, gender effect sizes were examined to understand the degree of effect and each effect size was calculated as small. Therefore, it was concluded as gender had little effect on mathematics related beliefs. Year level in EME program did not have effect on mathematics related beliefs as well.

5.2 Major Findings and Discussions

In this part of this chapter Turkish preservice teachers' mathematics related beliefs and effect o gender and year level are discussed as follows.

5.2.1 Turkish Preservice Teachers' Mathematics Related Beliefs

Results of the analysis showed that, Turkish preservice teachers had rather constructivist beliefs as students should participate in the building process of mathematical concepts for understanding them and it was important for mathematics education to provide active discussion environment for students. Moreover, they described mathematics as an unfinished product which was also a richer belief for preservice mathematics teachers. New elementary mathematics education program of Turkey was developed over similar constructivist and rich beliefs (MEB, 2009). Since preservice teachers will be using this program in their future career life, principles of this program was repeated very often at teacher education programs. This could be reason for preservice mathematics teachers' constructivist beliefs.

Turkish preservice elementary mathematics teachers also believed that reaching correct answer while solving problems by using the ways that were taught during the lesson was important and teacher's solution steps should be followed step by step during the mathematics lesson. These exemplified the traditional and rather poor beliefs that preservice teachers had. Similarly, Raymond (1997) addressed that teachers tended to believe reaching correct answer was more important than the process of solving problem. In the case of Turkey, this might be due to the national examinations which students have to take in order to access better high schools or attend a university. The shadow education institutions in Turkey prepare students for national examinations by emphasizing reaching correct response in a limited time mostly in very structured short ways. Therefore, preservice teachers might have developed these beliefs before attending the teacher education programs and maintain them through their training (Haser, 2009).

Kayan (2007) found that Turkish preservice teachers slightly agreed with the idea that students should solve problems by step by step procedures and they believed that students should be allowed to develop their own methods to solve problems. Parallel to these results, results of this study showed that participating preservice mathematics teachers believed that students should have a possibility to formulate problems by themselves and then solve them. Preservice mathematics teachers agreed with the belief that students should have the opportunity to reach the same result in different ways and ideas developed by students should be taken into consideration. It seemed that preservice elementary mathematics teachers had two contradictory beliefs addressing the nature of problem solving in mathematics classrooms. They both believed in the importance of reaching the correct answer in teachers' ways and importance of development of students' own solution strategies. This might be explained by considering that beliefs are held in clusters (Green, 1971). Preservice teachers seemed to have two rather contradictory beliefs since they developed these beliefs in two different clusters as one was developed through the pre-college education and one was developed during teacher education. It might be the case that preservice teachers did not have experiences in which they would realize these two contradictory beliefs.

Certain results of this study did not match with the findings of Haser's (2006) study. Haser (2006) found out through the interviews with preservice and beginning teachers that preservice and beginning teachers believed that students would like mathematics lesson if they would like their mathematics teacher. The results of the current study showed that preservice mathematics teachers did not believe that feelings towards the mathematics teachers affected students' feelings about mathematics course.National Council of Teachers Mathematics, (2000) claimed that "technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning. Teachers' attitudes play an important role in using technology in teaching and learning mathematics" (p. 24). Turkish preservice teachers' beliefs were parallel with this view as they believed that visual and concrete representations and materials should be used as often as possible to develop positive attitude towards mathematics. They believed that the use of technology and learning games should be emphasized during mathematics teaching.

Yates (2006) stated that mathematical knowledge is developed by organizing the information learned by experiences. Results of this study were showed that the preservice teachers believed that arranging previous experience helped in developing mathematical knowledge.

Turkish preservice mathematics teachers had neutral beliefs about nature of mathematics and nature of teaching mathematics according to the findings of this study. For example, they did not completely agree or disagree with the belief that mathematical knowledge consists of facts, rules, and procedures. Previous studies conducted at abroad generally addressed that preservice teachers were likely to have such traditional beliefs (AlSalouli, 2004; Benbow, 1993; Civil, 1990; Nisbert & Warren, 2000). However, findings of the study showed that Turkish preservice teachers tended to have rather constructivist beliefs and they did not agree with many traditional belief items. This might also be related to the emphasis on the new elementary mathematics education program in Turkey in teacher education programs.

Consequently, the results of the present study addressed that Turkish preservice elementary mathematics teachers were likely to have beliefs which contradicted to each other most probably due to the clustered nature of the beliefs. The different experiences in pre-college years and teacher education programs might have caused these two different clusters of beliefs. The present study was conducted with 3rd and 4th year preservice elementary mathematics teachers at the end of the spring semester. Preservice teachers in EME programs attend two methods courses in the third year of the program in two semesters which emphasize mostly constructivist approaches in teaching mathematics. Therefore, the rather constructivist mathematics related beliefs Turkish preservice teachers had might have developed during these courses.

5.2.2 Beliefs in Terms of Gender and Year Level

The influence of the gender and year level in the EME program on preservice teachers' mathematics related beliefs was investigated by two-way between groups ANOVA for each component of the MRBS. Results of the ANOVA analysis showed that there was very small significant difference on preservice teachers' beliefs in terms of gender. For both components, mean score of females was measured as higher than mean score of males. However, this difference was quite low. While male students generally agreed on items of the scale, female students' agreement seemed stronger than males. Several studies investigating differences in terms of gender have been conducted for specific types of belief. These studies claimed that there was no significant difference on preservice teachers' self-efficacy beliefs in terms of gender (Goodwin, Ostrom, Scott, 2009; Işıksal, 2005). However, Ercikan, McCreith, and Lapointe (2005) stated that gender was a controversial issue for educational field.

The results of the study showed that there was no significant difference on belief scores of preservice teachers in terms of year level. Literature showed that teacher education program courses would not completely change but would partially affect preservice teachers' beliefs (Ambrose, 2004; Anderson & Bird, 1995; Foss & Kleinsasser, 1996; Gill, Ashton, Algina, 2004; Joram & Gabriele, 1998). It might be assumed that the practice teaching courses in the last year of the EME programs would have an influence on preservice elementary mathematics teachers' beliefs.

However, the results of the present study seemed to address that these courses did not have an effect. This might be due to the insufficient nature of the practice courses in terms of providing preservice teachers with actual teaching experiences. Therefore, considering the experience-driven nature of beliefs (Sigel, 1980), since 4th year preservice teachers did not have sufficient teaching experiences in which they would teach through the guidance of their beliefs in the classroom, their beliefs did not differ from 3rd year preservice teachers' beliefs.

5.3 Implication and Recommendations

The aim of this study was to develop a valid and reliable Mathematics Related Belief Scale. The MRBS have provided a new and current instrument for the field of mathematics teacher education in Turkey. By the help of MRBS, it was seen that Turkish preservice mathematics teachers simultaneously held contradictory beliefs. They had both traditional and constructivist beliefs at the same time which addressed that EME programs were partially successful in providing preservice teachers with rich beliefs. The MRBS could be used by teacher educators in understanding the preservice teachers' mathematics related beliefs and the influence of the program courses on these beliefs. Moreover, considering that the preservice teachers would tend to maintain their pre-college beliefs (Lampert, 1990), 1st year preservice teachers' mathematics related beliefs could be investigated through the MRBS in order to determine the nature of teacher education program course experiences.

The findings of this study focused on the slight mean difference especially on 3rd year female and male preservice teachers' belief scores for both Constructivist Beliefs and Traditional Beliefs. The reasons of slight mean difference of females and males of 3rd year preservice teachers can be related with their education programs and their courses. For the further research, it can be suggested to investigate the reasons of this significant difference. Moreover, it can be suggested MRBS was administered to more universities and larger data can be collected. Hence, further studies can be conducted to improve MRBS.

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APPENDIX A

MATHEMATICS RELATED BELIEFS FRAMEWORKS

Complete list of Characterizations in Thompson's (1991) Framework

(as cited Haser, 2006, p.202)

Table A.1: *Thompson's (1991) Framework that Characterizes Mathematics Related Belief Levels.*

Levels	Characterization
Level 0	• Mathematics is basically the usage of arithmetic skills in daily life. • Mathematical knowledge is composed of facts, rules and procedures. • The goal of the mathematics instruction is to obtain the correct/accurate answer, through the ways demonstrated in the class. • Mathematics teaching is developing students' arithmetic skills through memorization of rules without mentioning relationships among them. • Textbook is followed to teach mathematics without considering relevancy of the concepts. • Teacher's role is to demonstrate the procedures as mathematical knowledge. • Student's role is to imitate and extensively practice the procedures the teachers had just demonstrated. • There is an authority, either the teacher or the text book, for the correctness/accuracy of mathematical knowledge.
Level 1	• Mathematics is composed of rules and procedures with the principles behind them. • The distinction between the meanings and skills in the mathematical concepts has just initiated. • Conceptual analysis of content domains and appreciation of complexity of mathematical content has just started. • Teaching through manipulative is associated with attitudinal goals and empirical justification rather than cognitive goals and making connections to mathematical concepts. • Teaching for conceptual understanding is using pedagogical tasks and instructional representations to explain isolated sets of concepts and procedures. • Problem solving is taught separately from the mathematical content. • Integrating problems in the content means spreading problems unrelated to the content. • Teaching "about" problem solving (i.e. selection of strategies) takes place rather than teaching "with" problem solving (i.e. using it as an instructional approach). • Pedagogical decisions are based on perceptions of experts rather than cognitive effectiveness of instructional practices. • Students put effort to understand the justification of the mathematical procedures. • Experts are still an authority for the correctness/accuracy of the mathematical procedures.
Level 2	• The importance of various concepts and centrality of various ideas in mathematics are realized through understanding the relationships between them. • Proof and generalization processes are considered as a part of mathematics teaching and learning. • Visual and concrete representations are designed to provide students contexts that they can explore their ideas. • Teachers guide and provide opportunities for students' understanding through carefully designed pedagogical approaches. • Student-generated ideas are considered as important. • Students must involve in constructing mathematical ideas in order to understand them better. • The goal of instruction is develop students' reasoning through investigating mathematical ideas.

Complete List of Characterizations in Lindgren's (1996) Framework

(as cited Haser, 2006, p.203)

Table A.2 :*Lindgren's (1996) Framework that Characterizes Mathematics Related Belief Levels.*

Levels	Characterization
Rules and Routines (*Level 0*)	• Above all one should teach mathematical knowledge i.e. facts, rules, and statements. • When solving problems, it is most important that the students get the right answers. • In teaching one should use as often as possible such routine problems, where the correct answer can be achieved by using a familiar method. • In learning mathematics, it is most important that pupils practice extensively. • Above all, the pupils should learn to master basic calculation. • The most important task for the teacher is to maintain good order in the class.
Discussion and Games (*Level 1*)	• Above all the teacher should try to promote active class discussions. • In the math class one has to emphasize individual work. • In teaching mathematics, the teacher should let the students use many learning games. • In the teaching process one should promote the pupil's ability to work with other pupils.
Open-Approach (*Level 2*):	• The student should have the possibility to experience that the same result can be achieved in different ways. • The teacher should encourage the students to find different strategies for solving problems, and to discuss these strategies. • The pupils should have a possibility to formulate problems by themselves and then solve them. • The students should use concrete manipulative as often as possible. • In teaching mathematics one should use many verbal problems where the student must apply his knowledge. • One should use, as often as possible, problems where the student has to think first, and where the mastery of calculation alone will not lead to the solving of the problem. • During math lessons one should emphasize the importance of mathematical thinking. • One should consider the possible situations for the use of computers in the teaching of mathematics.

Complete List of Characterizations in Ernest's (1989) Framework

(as cited Haser, 2006, p.204)

Table A.3: *Ernest's (1989) Model that Characterizes Mathematics Related Belief Levels.*

Models	Levels
Conception of Nature of Mathematics	• *Instrumentalist View*: Mathematics as a set of tools that include unrelated facts, rules and skills used in order to reach an external end product • *Platonist View*: Mathematics as a static but combined body of knowledge, in which there are structures and truths connected to each other by logic and meaning. Mathematics is not created but discovered • *Problem-solving View*: Mathematics as a dynamic, problem-driven, continually expanding field in which there is a process of knowledge generation. Mathematics is not seen as a finished product
Models of Teaching Mathematics	• the day to day survival model • the mastery of skills and facts model • the mastery of skills and facts with conceptual understanding model • the conceptual understanding model • the conceptual understanding enriched with problem-solving model • the pure investigational, problem posing and solving model
Models of Learning Mathematics	• child's complaint behavior model. • child's linear progress through curricular scheme model • child's mastery of skills model • child's constructed understanding driven model • child's constructed understanding and interest driven model • child's exploration and autonomous pursuit of own interests model

APPENDIX B
Initial Version of the MRBS

MATEMATİK, ÖĞRETİMİ VE ÖĞRENİMİNE İLİŞKİN İNANIŞLAR ÖLÇEĞİ

		Kesinlikle Katılıyorum	Katılıyorum	Nötr	Katılmıyorum	Kesinlikle Katılmıyorum
1	Matematik temelde aritmetik becerilerin günlük hayatta kullanımıdır.					
2	Öğrenciler matematiksel kavramları anlamak için onları inşa etme sürecine katılmalılardır.					
3	Öğretmenin aktif sınıf tartışmasını teşvik etmesi matematik eğitiminde önemlidir.					
4	Matematik bilgisi olgular, kurallar, ve işlemlerden oluşur.					
5	Matematik öğretiminin amacı öğrencilerin matematiksel kavramları araştırarak akıl yürütmelerini geliştirmektir.					
6	Matematik öğretirken öğrencilerin aritmetik yeteneklerini artırmak için, kuralların arasındaki ilişkilerden ziyade kuralların ezberletilmesine odaklanılmalıdır.					
7	Matematik öğretiminde konular arasındaki ilişkiden çok ders kitabındaki sıra takip edilmelidir.					
8	Matematik öğretmeninin rolü işlemleri matematiksel bilgi olarak göstermektir.					
9	Matematikte bazı kavramlar diğer kavramlarla olan ilişkilerinden dolayı daha merkezi ve önemli durumdadır.					
10	Matematiği öğrenmek için matematik konuları hakkında çok soru çözmek gerekir.					
11	Matematikte, bir bilgi eğer kitapta verilmiş veya öğretmen tarafından anlatılmışsa doğrudur.					
12	Matematik dersinde matematiksel düşünmenin önemi vurgulanmalıdır.					
13	Öğretmenler dikkatle tasarlanmış pedagojik yaklaşımlardan yararlanarak öğrencilerin matematiksel kavramalarının gelişmesi için fırsatlar sağlamalıdır.					
14	Problemleri çözerken en önemli şey öğrencilerin doğru cevabı bulmasıdır.					
15	Matematik öğretirken öğretmen öğrencilerin çeşitli öğrenme oyunları kullanmasına izin vermelidir.					
16	Matematik öğretiminde daha önce gösterilen yöntemlerle çözülebilen problemler mümkün olduğu kadar sık sorulmalıdır.					
17	Matematik öğrenirken en önemli şey öğrencilerin çok fazla pratik yapmasıdır.					
18	Problem çözme bir öğretim stratejisi olarak matematik eğitiminde kullanılmalıdır.					
19	Matematiksel olgular, kurallar, ve ifadelerin öğretilmesi matematik eğitiminde önceliklidir.					

		Kesinlikle Katılıyorum	Katılıyorum	Nötr	Katılmıyorum	Kesinlikle Katılmıyorum
20	Matematikte hâlâ üretilecek bilgi vardır.					
21	Öğrenciler matematiksel problemleri kendileri oluşturma ve çözme fırsatına sahip olmalılardır.					
22	Matematik sadece kurallar, işlemler, ve bunların arkasındaki ilkelerden oluşan durağan bilgi bütünüdür.					
23	Matematik öğretiminde öğrencilerin önce düşünmek zorunda oldukları ve sadece işlemleri doğru bir şekilde yapmanın çözüme götürmeyeceği problemler mümkün olduğunca sık kullanılmalıdır.					
24	Görsel ve somut gösterimler öğrencilerin fikirlerini araştırabilecekleri ortamları sağlamak için düzenlenir.					
25	Öğrenciler aynı sonuca farklı yollardan ulaşabilmeyi tecrübe etme fırsatına sahip olmalılardır.					
26	İspat ve genelleme matematik öğretimi sürecinin önemli bir parçasıdır.					
27	Matematik öğretiminde materyaller sadece tutumla ilgili amaçlara ulaşmak ve deneysel bir doğrulama yapmak amacıyla kullanılır.					
28	Bir matematik konusu ile ilgili problem çözme konudan bağımsız olarak öğretilmelidir.					
29	Öğrenciler matematiksel işlemlerin gerekçelerini anlamak için çaba harcamalılardır.					
30	Matematik öğretiminin amacı derste gösterilen yolları kullanarak doğru cevabı elde etmektir.					
31	Matematik öğretiminde öğrenciler tarafından geliştirilen fikirler dikkate alınmalıdır.					
32	Matematik öğretimi sürecinde öğrenciler birbirleri ile çalışmaya teşvik edilmelidir.					
33	Matematik dersinde öğrenciler somut materyalleri mümkün olduğunca sık kullanmalılardır.					
34	Matematik eğitiminde teknolojinin olası kullanım durumları dikkate alınmalıdır.					
35	Matematik öğretiminde öğrencilerin bilgilerini uygulayabilecekleri bir çok sözel problem kullanılmalıdır.					
36	Öğrencilerin matematiği sevmeleri için önce matematik öğretmenini sevmeleri gerekir.					
37	Matematik öğretiminde materyaller öncelikli olarak bilişsel amaçlara ulaşmak ve matematiksel kavramlarla bağlantı kurmak amacıyla kullanılır.					
38	Problem çözme matematik dersinde bir çözüm yolu yaklaşımı olarak kullanılmalıdır.					

APPENDIX C

Second Version of the MRBS

MATEMATİK, ÖĞRETİMİ VE ÖĞRENİMİNE İLİŞKİN İNANIŞLAR ÖLÇEĞİ

		Katılıyoru m	Katılıyoru m	Nötr	Katılmıyor um	Kesinlikle Katılmıyor um
1	Matematik temelde aritmetik becerilerin günlük hayatta kullanımıdır.					
2	Öğrenciler matematiksel kavramları anlamak için onları inşa etme (2) sürecine katılmalılardır.					
3	Öğretmenin aktif sınıf tartışmasını teşvik etmesi matematik eğitiminde önemlidir. (2)					
4	Matematik bilgisi olgular, kurallar, ve işlemlerden oluşur.					
5	Matematik öğretiminin amacı öğrencilerin matematiksel kavramları araştırarak akıl yürütmelerini geliştirmektir.					
6	Matematik öğretirken öğrencilerin aritmetik yeteneklerini (2) artırmak için, kuralların arasındaki ilişkilerden ziyade kuralların ezberletilmesine odaklanılmalıdır.					
7	Matematik öğretiminde konular arasındaki ilişkiden çok ders kitabındaki sıra takip edilmelidir.					
8	Matematik öğretmeninin rolü (2) işlemleri matematiksel bilgi olarak göstermektir.					
9	Matematikte bazı kavramlar diğer kavramlarla olan ilişkilerinden dolayı daha merkezi ve önemli durumdadır. (3)					
10	Matematiği öğrenmek için matematik konuları hakkında (2) çok soru çözmek gerekir.					
11	Matematikte, bir bilgi eğer kitapta verilmiş veya öğretmen tarafından anlatılmışsa doğrudur.					
12	Matematik dersinde matematiksel düşünmenin önemi vurgulanmalıdır.					
13	Öğretmenler dikkatle tasarlanmış pedagojik yaklaşımlardan yararlanarak öğrencilerin matematiksel kavramalarının gelişmesi için fırsatlar sağlamalıdır. (3)					
14	Problemleri çözerken en önemli şey öğrencilerin doğru cevabı bulmasıdır.(3)					
15	Matematik öğretirken öğretmen öğrencilerin çeşitli öğrenme oyunları kullanmasına izin vermelidir (2).					
16	Matematik öğretiminde daha önce gösterilen yöntemlerle çözülebilen problemler mümkün olduğu kadar sık sorulmalıdır. (3)					
17	Matematik öğrenirken en önemli şey öğrencilerin çok fazla pratik yapmasıdır. (3)					
18	Problem çözme bir öğretim stratejisi olarak matematik eğitiminde kullanılmalıdır. (3)					
19	Matematiksel olgular, kurallar, ve ifadelerin öğretilmesi matematik eğitiminde önceliklidir. (3)					

		Katılıyorum	Katılıyorum	Nötr	Katılmıyorum	Kesinlikle Katılmıyorum
20	Matematikte hâlâ üretilecek bilgi vardır.					
21	Öğrenciler matematiksel problemleri kendileri oluşturma ve çözme fırsatına sahip olmalılardır.					
22	Matematik sadece kurallar, işlemler, ve bunların arkasındaki ilkelerden oluşan durağan bilgi bütünüdür. (3)					
23	Matematik öğretiminde öğrencilerin önce düşünmek zorunda oldukları ve sadece işlemleri doğru bir şekilde yapmanın çözüme götürmeyeceği problemler mümkün olduğunca sık kullanılmalıdır. (3)					
24	Görsel ve somut gösterimler öğrencilerin fikirlerini araştırabilecekleri ortamları sağlamak için düzenlenir. (4)					
25	Öğrenciler aynı sonuca farklı yollardan ulaşabilmeyi tecrübe etme (2) fırsatına sahip olmalılardır.					
26	İspat ve genelleme matematik öğretimi sürecinin önemli bir parçasıdır.					
27	Matematik öğretiminde materyaller sadece tutumla ilgili amaçlara ulaşmak ve deneysel bir doğrulama yapmak amacıyla kullanılır. (4)					
28	Bir matematik konusu ile ilgili problem çözme konudan bağımsız olarak öğretilmelidir. (3)					
29	Öğrenciler matematiksel işlemlerin gerekçelerini (2)anlamak için çaba harcamalılardır.					
30	Matematik öğretiminin amacı derste gösterilen yolları kullanarak doğru cevabı elde (2) etmektir.					
31	Matematik öğretiminde öğrenciler tarafından geliştirilen fikirler dikkate alınmalıdır.					
32	Matematik öğretimi sürecinde öğrenciler birbirleri ile çalışmaya teşvik edilmelidir.					
33	Matematik dersinde öğrenciler somut materyalleri mümkün olduğunca sık kullanmalılardır. (4)					
34	Matematik eğitiminde teknolojinin olası kullanım durumları dikkate alınmalıdır. (2)					
35	Matematik öğretiminde öğrencilerin bilgilerini uygulayabilecekleri bir çok sözel (2) problem kullanılmalıdır. (4)					
36	Öğrencilerin matematiği sevmeleri için önce matematik öğretmenini sevmeleri gerekir.					
37	Matematik öğretiminde materyaller öncelikli olarak bilişsel amaçlara ulaşmak ve matematiksel kavramlarla bağlantı kurmak amacıyla kullanılır.(3)					
38	Problem çözme matematik dersinde bir çözüm yolu yaklaşımı olarak kullanılmalıdır. (3)					
39	Matematiksel bilgi öğrencilerin deneyimlerinden kazandıkları bilgileri organize etmeleri sonucunda oluşur. (1)					

(1) Additional item to the initial version of MRBS

(2) Removed items

(3) Removed or changed words in the last version of MRBS

(4) Changed items

APPENDIX D

Last version of the MRBS

MATEMATİK HAKKINDAKİ İNANIŞLAR ÖLÇEĞİ

Bu çalışma, Orta Doğu Teknik Üniversitesi İlköğretim Fen ve Matematik Alanları Eğitimi yüksek lisans öğrencisi Ruhan Kayan tarafından Y.Doç.Dr. Çiğdem Haser danışmanlığında yürütülen yüksek lisans tezi için yapılan bir çalışmadır. Bu çalışmanın amacı matematik öğretmen adayları ve matematik öğretmenleri için güvenilir ve geçerli bir matematik hakkındaki inanışlar ölçeği hazırlamaktır.

Çalışmaya katılım tamamıyla gönüllülük temelinde olmalıdır. Ankette, sizden kimlik belirleyici hiçbir bilgi istenmemektedir. Cevaplarınız tamimiyle gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir; elde edilecek bilgiler bilimsel yayımlarda kullanılacaktır. Anket sonunda, bu çalışmayla ilgili sorularınız cevaplanacaktır. Çalışma hakkında daha fazla bilgi almak için;
Ruhan Kayan (Tel: 0 505 221 14 90; E-posta: ruhan_14@yahoo.com)
veya
Y.Doç.Dr. Çiğdem Haser (Tel: 0312 210 6415; E-Posta: chaser@metu.edu.tr)
ile iletişim kurabilirsiniz.

Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz...

1. **Cinsiyetiniz:** ① Bayan ② Bay
2. **Üniversiteniz:** ....
3. **Bölümünüz:** ....
4. **Sınıfınız:** ① 1 ② 2 ③ 3 ④ 4

MATEMATİK, ÖĞRETİMİ VE ÖĞRENİME İLİŞKİN İNANIŞLAR ÖLÇEĞİ

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1. Öğrencilerin matematiksel kavramları anlayabilmeleri için bu kavramların oluşum sürecine katılmaları gerekir.	1	2	3	4	5
2. Öğretmenin, öğrencinin aktif olduğu sınıf tartışmasını oluşturması matematik eğitiminde önemlidir.	1	2	3	4	5
3. Matematik, temelde aritmetik becerilerin günlük hayatta kullanımıdır.	1	2	3	4	5
4. Matematik bilgisi olgular, kurallar ve işlemlerden oluşur.	1	2	3	4	5
5. Matematik öğretiminin amacı öğrencilerin matematiksel kavramları araştırarak akıl yürütmelerini geliştirmektir.	1	2	3	4	5
6. Matematik öğretirken öğrencilerin işlemsel becerilerini artırmak için, kuralların arasındaki ilişkilerin kurgulanması yerine kurallar ezberletilmelidir.	1	2	3	4	5
7. Matematik öğretiminde konular arasındaki mantıksal ilişkilerden çok ders kitabındaki sıra takip edilmelidir.	1	2	3	4	5
8. Matematik öğretmeni işlemleri matematiksel bilgi olarak göstermelidir.	1	2	3	4	5
9. Matematiği öğrenmek için öğrenciler çok soru çözmelidir.	1	2	3	4	5
10. Matematikte, bir bilgi eğer kitap veya öğretmen tarafından anlatılmışsa kesinlikle doğrudur.	1	2	3	4	5
11. Matematik dersinde matematiksel düşünmenin önemi vurgulanmalıdır.	1	2	3	4	5

DEVAMI İÇİN ARKA SAYFAYI ÇEVİRİNİZ.

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
12. Matematik öğretiminde öğretmenler matematiksel oyunlardan da yararlanmalıdır.	①	②	③	④	⑤
13. Matematik öğretiminde öğrencilerin daha önce karşılaşmadıkları şekildeki problemleri mümkün olduğunca sık sormak gerekir.	①	②	③	④	⑤
14. Matematik dersinde bir kavram problem durumları da yaratılarak öğretilebilir.	①	②	③	④	⑤
15. Matematikte hâlâ üretilebilecek yeni bilgiler vardır.	①	②	③	④	⑤
16. Öğrenciler matematiksel problemleri kendileri oluşturma ve çözme fırsatına sahip olmalıdır.	①	②	③	④	⑤
17. Matematik öğretiminde görsel ve somut gösterimler, materyaller mümkün oldukça sık kullanılmalıdır.	①	②	③	④	⑤
18. Öğrenciler aynı sonuca farklı yollardan ulaşabilme fırsatına sahip olmalıdır.	①	②	③	④	⑤
19. İspat ve genelleme matematik öğretimi sürecinin önemli bir parçasıdır.	①	②	③	④	⑤
20. Matematik öğretiminde materyal ve somut gösterimleri kullanmanın amacı öğrencilerde olumlu tutum geliştirmektir.	①	②	③	④	⑤
21. Matematik öğretiminde, konu sonunda problem çözerken öğretmenin öğrettiği basamaklar sırasıyla izlenmelidir.	①	②	③	④	⑤
22. Öğrenciler matematik dersinde kullanılan işlemlerin sebeplerini anlamak için çaba harcamalıdır.	①	②	③	④	⑤
23. Matematik öğretiminin amacı soru çözerken derste gösterilen yolları kullanarak doğru cevaba ulaşmaktır.	①	②	③	④	⑤
24. Matematik öğretiminde öğrenciler tarafından geliştirilen fikirler de dikkate alınmalıdır.	①	②	③	④	⑤
25. Matematik öğretimi sürecinde öğrenciler birbirleri ile çalışmaya teşvik edilmelidir.	①	②	③	④	⑤
26. Matematik öğretiminde teknolojinin olası kullanımına da önem verilmelidir.	①	②	③	④	⑤
27. Matematik öğretiminde işlemlerin yanı sıra, öğrencilerin bilgilerini uygulayabilecekleri problemlere de yer verilmelidir.	①	②	③	④	⑤
28. Öğrencilerin matematiği sevmeleri için matematik öğretmenini sevmeleri gerekir.	①	②	③	④	⑤
29. Matematik diğer derslerle ilişkili olduğu için önemlidir.	①	②	③	④	⑤
30. Matematiksel bilgi öğrencilerin deneyimlerinden kazandıkları bilgileri organize etmeleri sonucunda oluşur.	①	②	③	④	⑤
31. Matematik öğretiminin amacı öğrencileri hayata hazırlamaktır.	①	②	③	④	⑤
32. Matematik eğitiminde materyaller ve somut gösterimler matematiksel kavramların gelişmesinde etkili değildir.	①	②	③	④	⑤

ÖĞRETMEN EĞİTİMİ ALANINA YAPTIĞINIZ KATKILARDAN DOLAYI TEŞEKKÜR EDERİZ

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APPENDIX E
Total Variance Explained Table for the Pilot Study

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	13,601	42,504	42,504	13,601	42,504	42,504
2	2,798	8,743	51,247	2,798	8,743	51,247
3	1,280	4,000	55,248	1,280	4,000	55,248
4	1,163	3,635	58,883	1,163	3,635	58,883
5	1,087	3,395	62,278	1,087	3,395	62,278
6	,949	2,966	65,245			
7	,894	2,794	68,038			
8	,818	2,556	70,594			
9	,791	2,473	73,067			
10	,765	2,390	75,457			
11	,745	2,328	77,785			
12	,643	2,009	79,794			
13	,613	1,915	81,709			
14	,572	1,789	83,497			
15	,530	1,656	85,154			
16	,465	1,455	86,608			
17	,440	1,375	87,983			
18	,402	1,256	89,240			
19	,394	1,231	90,471			
20	,370	1,155	91,626			
21	,331	1,033	92,660			
22	,309	,966	93,625			
23	,290	,906	94,531			
24	,270	,844	95,375			
25	,266	,831	96,206			
26	,251	,784	96,990			
27	,219	,683	97,674			
28	,187	,583	98,256			
29	,164	,514	98,770			
30	,162	,506	99,276			
31	,127	,396	99,671			
32	,105	,329	100,000			

Extraction Method: Principal Component Analysis.

APPENDIX F
Total Variance Explained Table for the Study

Total Variance Explained

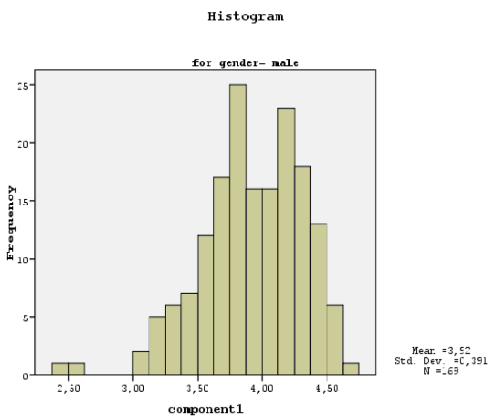
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7,847	24,521	24,521	7,847	24,521	24,521
2	3,069	9,589	34,110	3,069	9,589	34,110
3	1,350	4,218	38,328	1,350	4,218	38,328
4	1,271	3,973	42,301	1,271	3,973	42,301
5	1,159	3,622	45,923	1,159	3,622	45,923
6	1,100	3,439	49,362	1,100	3,439	49,362
7	1,002	3,133	52,495	1,002	3,133	52,495
8	,949	2,965	55,460			
9	,875	2,735	58,195			
10	,867	2,709	60,904			
11	,815	2,545	63,449			
12	,785	2,454	65,904			
13	,758	2,369	68,273			
14	,745	2,328	70,600			
15	,707	2,210	72,810			
16	,667	2,084	74,894			
17	,643	2,010	76,904			
18	,635	1,984	78,888			
19	,615	1,922	80,810			
20	,585	1,827	82,637			
21	,558	1,743	84,380			
22	,552	1,725	86,105			
23	,539	1,686	87,791			
24	,503	1,572	89,363			
25	,495	1,547	90,909			
26	,491	1,534	92,443			
27	,446	1,395	93,838			
28	,436	1,363	95,202			
29	,435	1,361	96,562			
30	,390	1,220	97,782			
31	,367	1,147	98,929			
32	,343	1,071	100,000			

Extraction Method: Principal Component Analysis.

APPENDIX G

Histograms and Normal Q-Q Plots for Each Component

Figure G1: Histograms of male and female students for Component 1



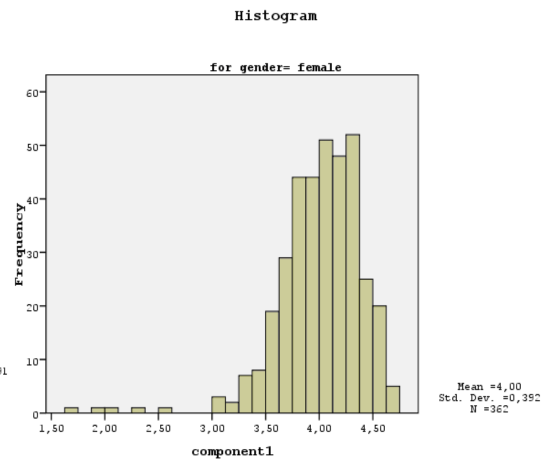
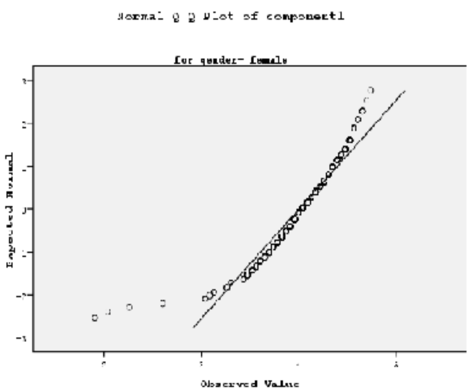


Figure G2: Normal Q-Q Plots of female and male for Component 1



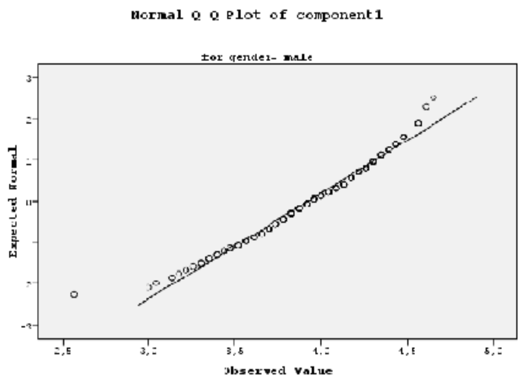
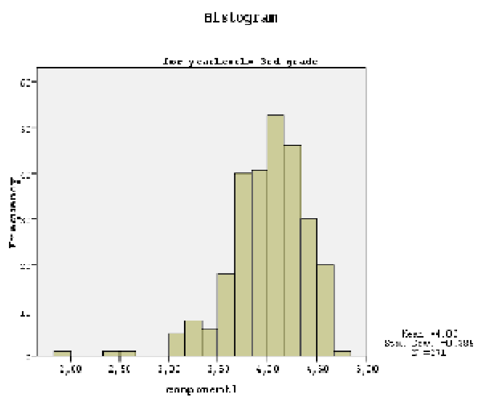


Figure G3: Histograms of 3^rd year and 4^th year students for Component 1



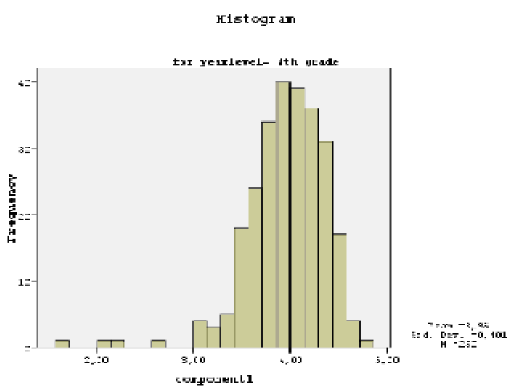
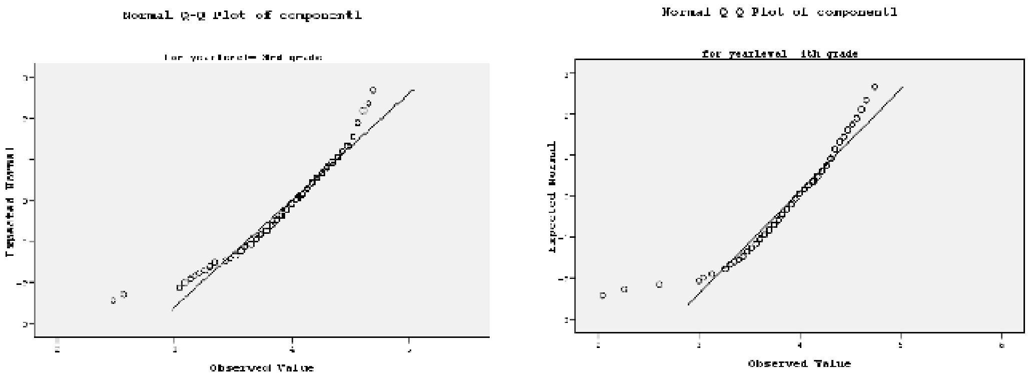
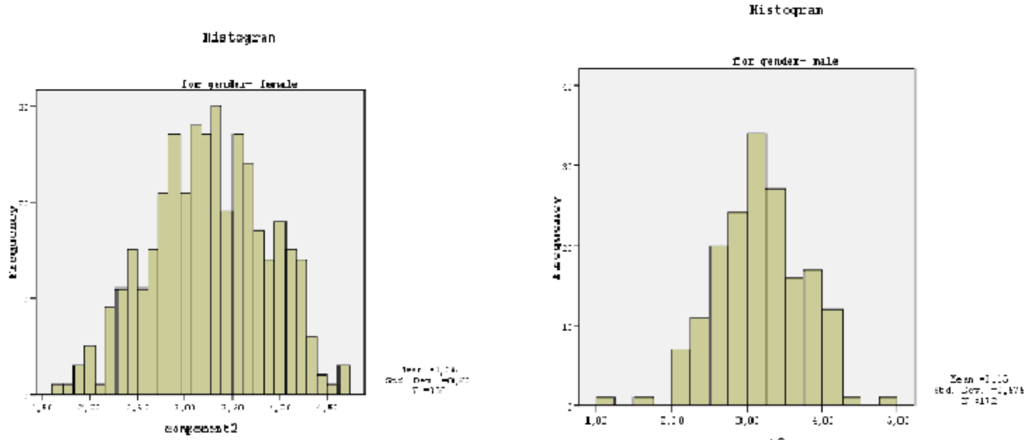


Figure G4: Normal Q-Q Plots of 3rd year and 4th year students for Component 1



Fi

gure G 5: Histograms of male and female students for Component



2

Figure G 6: Normal Q-Q Plots of female and male for Component 2

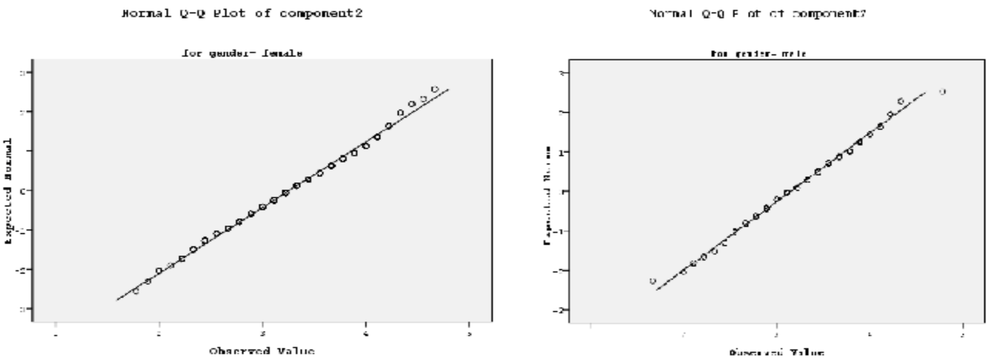


Figure G7: Histograms of 3rd year and 4th year students for Component 2

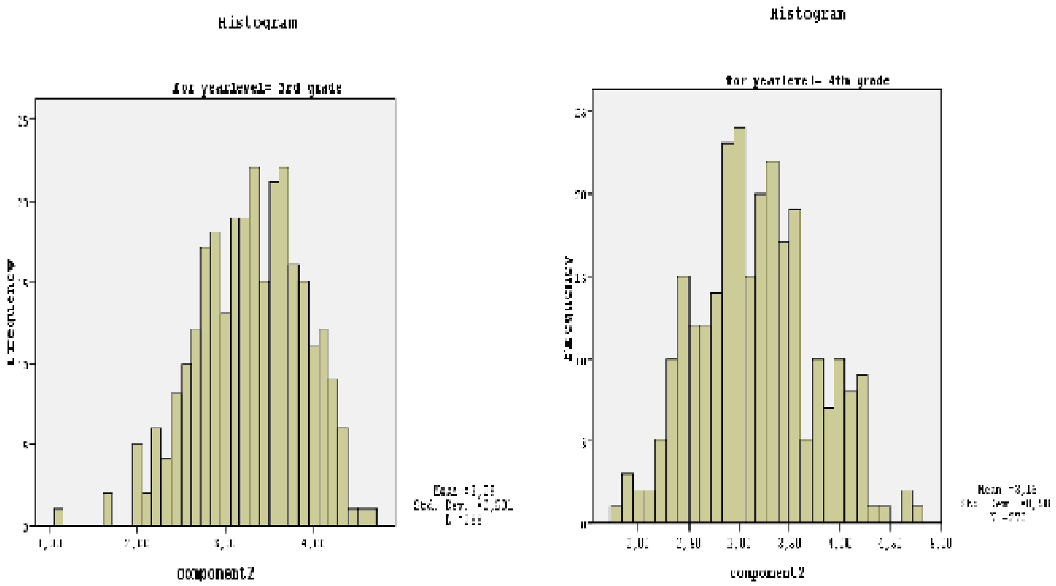


Figure G 8: Normal Q-Q Plots of 3rd year and 4th year students for Component 2