# PROSPECTIVE ELEMENTARY MATHEMATICS TEACHERS' KNOWLEDGE OF HISTORY OF MATHEMATICS AND THEIR ATTITUDES AND BELIEFS TOWARDS THE USE OF HISTORY OF MATHEMATICS IN MATHEMATICS EDUCATION

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# ABSTRACT

PROSPECTIVE ELEMENTARY MATHEMATICS TEACHERS' KNOWLEDGE OF HISTORY OF MATHEMATICS AND THEIR ATTITUDES AND BELIEFS TOWARDS THE USE OF HISTORY OF MATHEMATICS IN MATHEMATICS EDUCATION

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The aim of this study was to investigate the roles of year in teacher education program and gender on prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in the teaching and learning of mathematics. Moreover, the relationship between prospective teachers' knowledge of history of mathematics and their attitudes and beliefs about the history of mathematics usage was examined.

The data of the study were obtained from 1593 prospective teachers who were enrolled in first, second, third, and fourth years of Elementary Mathematics Education undergraduate program of nine universities located in seven geographical regions of Turkey through clustered random sampling. The scales used in the data collection were Knowledge of History of Mathematics (KHM) Test and Attitudes and Beliefs towards the Use of History of Mathematics in Mathematics Education (ABHME) Questionnaire.

The two-way ANOVA results clarified that prospective teachers' knowledge of history of mathematics improved as the years enrolled in the program increased. Results also revealed that males had significantly higher mean scores on KHM Test than females in the first two years of the program. In the third and fourth years, this situation reversed such that females had higher KHM mean scores, but this difference was not statistically significant.

Results also showed that prospective teachers' ABHME mean scores increased as years of enrollment in the program increased. More clearly, senior prospective teachers' relevant mean scores were significantly higher than that of freshmen and sophomores, and juniors' attitudes and beliefs were significantly higher than that of freshmen. In addition, females' ABHME mean scores were significantly higher than that of males for all years.

Lastly, a positive correlation between prospective elementary mathematics teachers' KHM mean scores and ABHME mean scores was found through Pearson product-moment correlation analysis.

Keywords: History of Mathematics, Knowledge, Attitudes and Beliefs, Prospective Elementary Mathematics Teachers

# ÖZ

İLKÖĞRETİM MATEMATİK ÖĞRETMEN ADAYLARININ MATEMATİK TARİHİ BİLGİLERİ VE MATEMATİK TARİHİNİN MATEMATİK EĞİTİMİNDE KULLANIMINA YÖNELİK TUTUM VE İNANIŞLARI

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Bu çalışmada öğretmen eğitim programındaki yıl ve cinsiyetin ilköğretim matematik öğretmen adaylarının matematik tarihi bilgileri ve matematik tarihinin matematik öğretim ve öğreniminde kullanımına yönelik tutum ve inanışları üzerindeki rolü araştırılmıştır. Ayrıca, öğretmen adaylarının matematik tarihi bilgileri ile onların söz konusu matematik tarihi kullanımı hakkındaki tutum ve inanışları arasındaki ilişki incelenmiştir.

Çalışmanın verileri Türkiye'nin her bir coğrafi bölgesindeki İlköğretim Matematik Öğretmenliği lisans programlarının birinci, ikinci, üçüncü ve dördüncü sınıf düzeylerinde okuyan 1593 öğretmen adayından tabakalı rastgele örneklem yöntemiyle toplanmıştır. Veri toplamada kullanılan ölçekler Matematik Tarihi Bilgi

Testi (KHM Test) ve Matematik Tarihinin Matematik Eğitiminde Kullanılmasına yönelik Tutum ve İnanışlar Anketi (ABHME Questionnaire) dir.

Çift-yönlü varyans analizi sonuçları öğretmen adaylarının matematik tarihi bilgisi ortalama puanlarının öğretmen eğitimi programındaki sınıf seviyesi ilerledikçe arttığını açığa çıkarmıştır. Programın ilk iki yılında erkek öğretmen adayları kadın öğretmen adaylarından anlamlı derecede daha yüksek matematik tarihi bilgisi ortalama puanlarına sahip olmuşlardır. Üçüncü ve dördüncü yıllarda bu durumun aksi gözlenmiştir, öyle ki kadın öğretmen adayları daha yüksek KHM ortalama puanlarına sahip olmuşlar, fakat bu fark istatistiksel olarak anlamlı bulunmamıştır.

Çift-yönlü varyans analizi ile ayrıca öğretmen adaylarının matematik tarihinin matematik eğitiminde kullanımına yönelik tutum ve inanış ortalama puanlarında programdaki sınıf seviyesine göre bir artış eğilimi bulunmuştur. Son sınıftaki öğretmen adaylarının ilgili ortalama puanları birinci ve ikinci sınıftakilere göre anlamlı derecede daha yüksek, üçüncü sınıftakilerin tutum ve inanışları ise birinci sınıftaki öğretmen adaylarından daha yüksektir. Ayrıca, kadın öğretmen adaylarının ABHME ortalama puanları anlamlı derecede erkeklerinkinden daha yüksektir.

Son olarak, ilköğretim matematik öğretmen adaylarının KHM ortalama puanları ve ABHME ortalama puanları arasında pozitif ilişki Pearson product-moment korelasyon analizi ile tespit edilmiştir.

Anahtar Kelimeler: Matematik Tarihi, Bilgi, Tutum ve İnanışlar, İlköğretim Matematik Öğretmen Adayları

**To My Family, and Zişan Güner**

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ABHME: Attitudes and Beliefs towards the Use of History of Mathematics in Mathematics Education

ANOVA: Analysis of Variance

CERME: Congress of the European Society for Research in Mathematics Education

$H_0$: Null Hypothesis

HEC: Higher Education Council

HPM: The International Study Group on the Relations between History and Pedagogy of Mathematics

ICMI: The International Commission on Mathematics Education

KHM: Knowledge of History of Mathematics

M: Mean

MoNE: Ministry of National Education

N: Number of Participants

NCTM: National Council of Teachers of Mathematics

SD: Standard Deviation

SE: Standard Error

$\sigma^2$: Variance

# CHAPTER 1

# INTRODUCTION

The initial ideas on a new and different field of study for mathematics educators, that is, the appearance of history of mathematics for mathematics education, has started by the end of the 1900s parallel to the development of history of mathematics as a branch of science (Furinghetti & Radford, 2002). It can be said that the rise of these two fields was late considering that human being have been doing mathematics for at least 4000 years (Fasanelli et. al, 2000). Nevertheless, there have been many attempts on behalf of incorporating history of mathematics into teaching and learning of mathematics at that relatively short time of about a century. The endeavor for this incorporation presumably is based on the opinion that the past and the present cannot be thought separately, like history of mathematics and the modern mathematics that students learn today (Radford, 1997). Poincare, who is one of the foremost mathematicians, denoted the importance of these two integral states of mathematics as follows: "The educators' task is to make children follow the path that was followed by their fathers, passing quickly through certain stages without eliminating any of them. In this way, the history of sciences has to be our guide." (as cited in Furinghetti & Radford, 2002). This alternative method for teaching mathematics was also considered as important for prospective mathematics teachers, who would be teaching mathematics in the near future. If they are expected to use this alternative method in their future profession, it is natural to expect that they know the historical background of the mathematical topics and concepts (Fried, 2001). In addition, their classroom behaviors are substantially affected by their attitudes and beliefs (Kagan, 1992; Koballa & Crawley, 1985; Li, 1999; Richardson, 1996). Therefore, this study was conducted to investigate Turkish prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics teaching and learning.

History of mathematics has been an issue in the teaching and learning of mathematics in schools for more than a century (Fried, 2001). The field fundamentally strains at including the historical origins of mathematical concepts into the mathematics classroom by means of some particular teaching tools such as, ancient problems and texts, historical information, plays, and videos designed by inspirations from the primary or secondary sources of mathematics (Tzanakis & Arcavi, 2000). There are many arguments about the usage of this alternative approach forwarded in the literature on the field. Jankvist (2009) analyzed these arguments, and mainly distinguished them as causations for (the 'whys') and the ways of (the 'hows') using history of mathematics in the teaching and learning of mathematics. With respect to his study, the causations are basically separated into two: for assisting the mathematics instruction and for learning of history of mathematics on its own. The first addresses that history of mathematics can help improve pupils' learning by means of affective, cognitive, and developmental aspects. The second refers to enlightening history of mathematics to make students form an idea on the evolution of mathematics in numerous cultures. As for the ways of including history of mathematics in the mathematics courses, one may benefit from three basic approaches: the 'illumination' which means including some factual information from the past to mathematics lessons, the 'modules' that a series of course sessions are integrated with history of mathematics, and the 'history-based' ones in which the mathematics classes are fully based on history and evolution of mathematics (Jankvist, 2009).

After the very general description of using history of mathematics in mathematics teaching was given accompanied by its 'whys' and 'hows', it became essential that having a brief look at the place of this alternative approach in different countries via the research and practices related to it. The place of the integration of history into mathematics education in different countries was addressed under two parts: the first referred to the international context for the field of history of mathematics in mathematics education and the second referred to the context of Turkey. It was intended to present the value and place of the historical teaching method in Turkey in comparison with its value and place in the international area.

National Council of Teachers of Mathematics (NCTM) pointed out that mathematics is a global scientific human success that different cultures inherited to us, and people should perceive and admire this reality (NCTM, 2003). It can be inferred that the importance of the historical method was indicated by NCTM secretly from the suggestion, which was manifested via a special book on the usage of history of mathematics in mathematics instruction (NCTM, 2004). The *International Commission on Mathematics Education* (ICMI) also have given a great importance to the issue and performed a special study on it, which focused basically on the place of the incorporation in some countries, its different usages, its employments in several educational environments with different participants, some arguments in favor and against it, and a bibliography for future research in the field (Fauvel & van Maanen, 2000). Furthermore, the experts of the field share their experiences with researchers and both pre- and in-service teachers who are interested in the incorporation of the history of mathematics with the education of its modern form in some special worldwide and local meetings like the *International Study Group on the Relations between History and Pedagogy of Mathematics* (HPM) which is a satellite meeting of the *International Congress on Mathematical Education* (ICME), and *Congress of the European Society for Research in Mathematics Education* (CERME).

The value of history of mathematics in connection with culture and society took place among the general aims of the national mathematics education curricula of some countries from all around the world by the end of the 20th century (Fasanelli et al., 2000). The textbooks edited considering these curricula gave narrow space to the history of mathematics (mostly increasing by the grade level), and those were through historical information. The use of history of mathematics in mathematics classroom was dependent on teachers whose pre-service training contained an arbitrary education on history of mathematics. The teaching method was used in some countries as a tradition (e.g., Italy), and it served to the politics in some other countries like improving nationalistic views of new generations (e.g., China) (Fasanelli et al., 2000). It is probable that there was an increasing trend of giving much more importance to history of mathematics in mathematics education in these nations in parallel with new studies on the matter. Moreover, there were attempts to the inclusion of history of mathematics from other countries like Turkey which did place history of mathematics in the curricula and textbooks in a very limited sense before the 21st century.

In Turkey, Ministry of National Education (MoNE) is the governing body of education up to university studies of students. MoNE have initiated reforms in national upper elementary (K6-8) mathematics curriculum in recent years (MoNE, 2005, 2009). It was also noticed that the recent research conducted on the use of history of mathematics in mathematics education was considered in these reforms. The importance of mathematics' history was clearly stated among the general purposes of mathematics education (MoNE, 2005). At this point, it was an object of concern that how the given importance to the use of history of mathematics reflected in elementary school mathematics. The formal textbooks (Durmuş, 2010a, 2010b, 2010c) prepared for the aforesaid purpose contains only some limited historical information about certain mathematical concepts, and offers only mathematics projects about history of mathematics on its application to mathematics education. That is to say, the place of history of mathematics in the textbooks appears as factual information that Jankvist (2009) named as ‘illumination’ approaches in his classification of the ‘hows’. These parts of historical information in these textbooks could be mostly for the learning of pure history of mathematics and for affective purposes rather than directly for the learning of mathematics. The following quote illustrates the place of history of mathematics in the formal Turkish textbooks: “Pythagoras, who is known as the father of numbers, lived between B.C. 580 and B.C. 500. His best known theorem is Pythagoras Theorem which is remembered with his name…” (Durmuş, 2010c, p. 80). This quotation, like the other history of mathematics related parts in the textbooks, indicates that the utilization from the past of mathematics is considered as the direct usage of historical factual information rather than learning activities, student tasks, and vice versa. On the other hand, the projects on history of mathematics rather focused on the scientists (their studies and these studies’ impacts on human life) than the mathematical concepts, and they are also based on students’ research on the historical information. Though, they necessitates that students make some inquisitions, criticisms and comments on the searched information about the past of mathematics as well.

The teacher education programs in Turkey also paid attention to the history of mathematics in elementary mathematics teaching. Higher Education Council (HEC) (2007), which is the institution responsible from higher education in Turkey, proposed some undergraduate elective courses regarding history and evolution of mathematics, namely History of Science, History of Mathematics, and Philosophy of Mathematics for the pre-service training of elementary mathematics teachers. In addition to these courses related to the history of mathematics, MoNE exhibited some attempts on in-service training units about the issue like survey applications to mathematics teachers about determining the in-service training needs of them regarding the use of history of mathematics in their mathematics lessons (MoNE, 2010).

In addition to the efforts on including history of mathematics into the elementary mathematics curriculum and the pre- and in-service training of teachers, there are also studies conducted in the educational conditions of Turkey whose efforts were on reflecting the affective aspects of the inclusion of the history making suggestions to mathematics teaching practices (e.g., Kar & İpek, 2009), and reflecting lesson plans on the integration of history of mathematics in mathematics courses (e.g., İlhan, 2011). Considering the previous studies conducted in Turkey and abroad, the present study aimed to make contributions to the field by investigating prospective teachers' knowledge about the history of mathematics and their substantial attitudes and beliefs towards using history of mathematics in mathematics education.

The proficiency of teachers regarding their instruction intrinsically creates a difference in the mathematics they are teaching and their students' learning (Grouws & Hiebert, 2007). One of the elements of making mathematics teachers proficient may be the knowledge they have related to their teaching. It has been investigated over two centuries on the purposes of improving the standards of education, exploring the effectiveness of prospective teacher training, and differentiating teaching profession from the others (Hill, Sleep, Lewis, & Ball, 2007). In other words, knowledge for both pre- and in-service teachers is a significant component in mathematics education because it states the limits about what they are able to teach. Among the aims of examining teacher knowledge that Hill, Sleep, Lewis and Ball (2007) introduced, this study paid attention to the second, which was about prospective teachers, with the particular component of mathematics education, the use of history of mathematics. For a prospective mathematics teacher who aims to make use of mathematics' history, it is naturally crucial that the knowledge he/she has about the historical frames of mathematical concepts, mathematicians, or events from history of mathematics are accurate, objective and satisfactory (of good quality) with how to employ them in mathematics learning process of students. In order to achieve this, they may be introduced history integrated mathematics knowledge on the grounds that the history of the mathematics subjects gives reliable knowledge, presents the paths to the evolution of concepts, not just the results (Freudenthal, 1981). As a conclusion, it can be said that knowledge of history of mathematics is an important element of a future mathematics teachers' qualifications. In addition, it is likely that the proficiency of knowledge about history of mathematics and how to use it in mathematics teaching have an impact upon prospective teachers' attitudes and beliefs concerning the use of the history in mathematics teaching and learning and this impact also can be in reverse.

There is no common description of individuals' beliefs or attitudes in the literature, the existing ones were subjectively created from the viewpoints of the researchers (Leder & Forgasz, 2002). Philipp (2007) characterized belief as what people themselves think as right or wrong independent from the others' agreement or disagreement to their thought. The term attitude can be illustrated by courtesy of an association with the concept belief as a less strict and more changeable form of belief (Thompson, 1992).

Philipp (2007) implied that affective matters like attitudes and beliefs are at least as important as the knowledge gained by students who learn mathematics. Therefore, mathematics teachers' attitudes and beliefs are considered as important , since they guide and assist students' learning experiences. Among the attitudes and beliefs regarding their profession, those towards possible teaching approaches take a considerable part that refers to which qualities of the approach are right or which of them are wrong from their point of view. These attitudes and beliefs probably reflect on their behaviors, or preferences, about the professed teaching methods (Philipp, 2007). In this study, the specific method of teaching is the incorporation of history of mathematics into mathematics lessons.

As being mathematics teachers of the future, prospective mathematics teachers' attitudes and beliefs towards the history usage have a great importance as well. The training process that they receive about how to teach mathematics is quite likely to affect their attitudes and beliefs about mathematics education. Particularly, having an idea about what they believe and how they would act regarding the use of history of mathematics in mathematics teaching is significant for determining their needs in order to shape their undergraduate education. Thus, one of the aims of this study is to find answers for the addressed affective issues in the usage of history of mathematics. When these affective issues and knowledge of history of mathematics were investigated, it was found required to include the factor of gender in this examination.

Gender of students and teachers has been an issue of researchers' concern. There were studies in the literature of mathematics education which investigated any possible effects of gender on achievements in the several learning areas of mathematics such as problem solving, probability and numbers; or on the affective issues like attitudes, beliefs, feelings and views towards the different components of mathematics learning and teaching (e.g., Duatepe-Paksu, 2008; Grevholm & Hanna, 1995; Tate, 1997). In brief, examining possible effects of gender differences on Turkish elementary mathematics teacher candidates' existing knowledge of history of mathematics and attitudes and beliefs towards the use of history of mathematics in mathematics education have been investigated in this study.

## 1.1. Problem, Research Questions, and Hypotheses of the Study

The study was carried out with the two main aims which were investigating the possible roles of year enrolled in teacher education program and gender on Turkish prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education, and examining a possible relationship between the prospective teachers' knowledge of history of mathematics and their attitudes and beliefs related to the history of mathematics usage. In accordance with these aims, the participants were determined as prospective elementary mathematics teachers in all years of enrollment from nine universities located in each geographic region of Turkey. The research questions and hypotheses of the study were formed by taking into consideration of the foregoing aims.

The present study has investigated the following research questions and related hypotheses:

1. To what extent do Turkish prospective elementary mathematics teachers have the knowledge of history of mathematics?

2. What is the level of attitudes and beliefs of Turkish prospective elementary mathematics teachers towards the use of history of mathematics in mathematics education?

3. Is there a significant mean difference in Turkish prospective elementary mathematics teachers' knowledge of history of mathematics with respect to year enrolled in teacher education program and gender?

3.1. Is there a significant interaction effect between year enrolled in teacher education program and gender with respect to knowledge of history of mathematics?

$H_0$: There is not a significant interaction effect between year enrolled in teacher education program and gender with respect to knowledge of history of mathematics.

3.2. Is there a significant mean difference in Turkish prospective elementary mathematics teachers' knowledge of history of mathematics with respect to year enrolled in teacher education program?

$H_0$: There is not a significant mean difference in Turkish prospective elementary mathematics teachers' knowledge of history of mathematics with respect to year enrolled in teacher education program.

3.3. Is there a significant mean difference between female and male Turkish prospective elementary mathematics teachers' knowledge of history of mathematics?

$H_0$: There is not a significant mean difference between female and female Turkish prospective elementary mathematics teachers' knowledge of history of mathematics.

4. Is there a significant mean difference in Turkish prospective elementary mathematics teachers' attitudes and beliefs towards the use of history of mathematics in mathematics education with respect to year enrolled in teacher education program and gender?

4.1. Is there a significant interaction effect between year enrolled in teacher education program and gender with respect to attitudes and beliefs towards the use of history of mathematics in mathematics education?

$H_0$: There is not a significant interaction effect between year enrolled in teacher education program and gender with respect to attitudes and beliefs towards the use of history of mathematics in mathematics education.

4.2. Is there a significant mean difference in Turkish prospective elementary mathematics teachers' attitudes and beliefs towards the use of history of mathematics in mathematics education with respect to year enrolled in teacher education program?

$H_0$: There is not a significant mean difference in Turkish prospective elementary mathematics teachers' attitudes and beliefs towards the use of history of mathematics in mathematics education with respect to year enrolled in teacher education program.

4.3. Is there a significant mean difference between female and male Turkish prospective elementary mathematics teachers' attitudes and beliefs towards the use of history of mathematics in mathematics education?

$H_0$: There is not a significant mean difference between female and male Turkish prospective elementary mathematics teachers' attitudes and beliefs towards the use of history of mathematics in mathematics education.

5. Is there a significant relationship between Turkish prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education?

$H_0$: There is not a significant relationship between Turkish prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education.

After stating the research questions and hypotheses, it was necessary that the important and common terms in these questions and hypotheses defined in details.

These definitions were assumed to give information about the meanings of the terms in the specific coherence of this study.

### 1.2. Definitions of the Important Terms

Oxford Dictionaries (2011a, 2011b) defined *history* as “the whole series of past events connected with a particular person or thing” and *mathematics* as “the abstract science of number, quantity, and space, either as abstract concepts (pure mathematics), or as applied to other disciplines such as physics and engineering (applied mathematics).” With reference to these constitutive definitions, *history of mathematics* can be described as the linked developments from the very past to the modern times related to the scientific branch of numbers, quantities, and space with its pure and applied versions. Considering these definitions, *knowledge of history of mathematics* was defined for this study as the factual historical information limited with the place of the history of mathematics with its five sub learning areas (numbers, geometry, probability and statistics, measurement, and algebra) in Turkish national upper elementary (K6-8) mathematics curriculum (MoNE, 2009) and its satellite textbooks (Durmuş, 2010a, 2010b, 2010c). Turkish prospective elementary mathematics teachers’ knowledge of history of mathematics was measured and assessed with Knowledge of History of Mathematics (KHM) Test which was precisely developed for this study.

*Attitudes and Beliefs towards the use of history of mathematics*: In Philipp’s (2007) aspect, attitudes are defined as “… manners of acting, feeling, or thinking that show one’s disposition or opinion.”, and beliefs are “…lenses that affect one’s view of some aspect of the world...” (p. 259). Towards the aim of the study and considering the study of Törner (as cited in Goldin, Rösken, & Törner, 2009), attitude and belief were not separated because of that beliefs are strongly related to attitudes. In this study, attitudes and beliefs refer to Turkish prospective elementary mathematics teachers’ thinking manners and that show their disposition or opinion about the use of history of mathematics in mathematics education, and their viewpoints to some aspects of the use of history of mathematics in mathematics education. Attitude and Belief Questionnaire towards Using History of Mathematics in Mathematics Education (ABHME Questionnaire) developed for this study was utilized to measure these attitudes and beliefs.

*The use of history of mathematics in mathematics education* as an alternative mathematics teaching approach is mainly based on utilizing mathematics’ primary and secondary sources for the aim of giving place to the origins of the concepts of mathematics through old mathematics problems, original mathematics texts, biographies of premier mathematicians, games, plays inspired by history of mathematics and the like (Tzanakis & Arcavi, 2000). It was situated in the item statements of the ABHME Questionnaire with its certain characteristics like its usability, its effects on the appreciation of mathematics as a discipline, its possible contributions to the learning of mathematics, and its place in teachers’ professional development.

*Turkish prospective elementary mathematics teachers* are the freshmen, sophomores, juniors, and seniors who are enrolled in elementary mathematics education undergraduate programs in the faculties of education which are located in every single geographical region of Turkey.

### 1.3. The Significance of the Study

The attempts for the incorporation of history of mathematics in mathematics instruction have been continued for about 150 years (Fried, 2001). In spite of the fact that this research field had a long past, the same could not be expressed for the mathematics education given in Turkey. It was started to being studied since the beginning of the 2000s. When the last pre-reformed version of the upper elementary (K6-8) curriculum examined, it may be forwarded that the history of mathematics was not emphasized adequately (MoNE, 2002). Initial discussions on the use of history of mathematics in elementary mathematics teaching joined the national curriculum in 2005 (MoNE, 2005), and the value of the usage was greatly stressed in the lastly modified curriculum (MoNE, 2009) as students should have an idea about the historical evolution of mathematics, its role on many other fields (e.g., other branches of science, engineering), its status and value in the development of human thoughts. Additionally, the curriculum offered the utilization of some historical materials like tangram, and the textbooks for the implementation of the curriculum (Durmuş, 2010a, 2010b, 2010c) covered fundamental historical information about the milestones of mathematics discipline.

Mathematics education researchers in Turkey have investigated some aspects of the issue (Baki & Güven; 2009; Bütüner, 2008; Gürsoy, 2010; İdikut, 2007; İlhan, 2011; Kar & İpek, 2009; Karakuş, 2009; Oprukçu-Gönülateş, 2004; Tözlüyurt, 2008). Most of these investigations were intended for teacher education. Among those, Oprukçu-Gönülateş (2004) detected no change in prospective mathematics teachers' attitudes towards the usage of history of mathematics after introducing it with an intervention process and she determined that they found it more appropriate for motivational purposes rather than for conceptual purposes. The prospective teachers also stated that it should be more integrated with the curriculum even with the purposes of motivation. Additionally, Gürsoy (2010) determined a positive change in prospective elementary mathematics teachers' attitudes and beliefs towards the elucidated use of history of mathematics after they were given a course on the history of mathematics. Baki and Güven (2009) presented a way of combining the old mathematics and the respectively new methods of teaching mathematics that refers to Khayyam's solution of cubic equations and cubic equations in dynamic geometry environment, respectively. The underlying reason of the tendency to studying with teacher candidates in these studies may probably be parallel to this study's reasons, which is the idea that students' learning of mathematics is going to be in prospective teachers' guidance in the future. On the one hand, their existing attitudes and beliefs towards history of mathematics integration into the teaching of mathematics would clarify how they considered integration as an alternative in their teaching repertoire, and whether they felt themselves prepared for the integration or not. It will also give signals about whether they want to use this approach or not. Prospective teachers' existing knowledge about the history of mathematics may reveal their incompleteness on the matter which would give an idea about the extent to which they are familiar with the historical background of the branch they are going to teach and what could be done to improve this kind of knowledge.

The above issues addressing prospective teachers' existing knowledge about the history of mathematics and their existing attitudes and beliefs on the use of history in mathematics education are thought to comprise important information initially for prospective mathematics teacher education. For example, it may be a promoter of a specific elective course on the use of history of mathematics in mathematics education and/or that the existing elective history of mathematics undergraduate courses would be expanded to be a must course in the elementary mathematics teacher education program.

In addition to the implications for teacher education programs, it is believed that the study would give signals for the improvements and developments of in-service teacher training programs and seminars on the matter, the existing curriculum for elementary mathematics education with historical activities and new historical materials, the design of elementary mathematics textbooks, and the translation of the international books regarding the topic (e.g., Calinger, 1996; Fauvel & van Maanen, 2000; NCTM, 2004).

When the research field of including history of mathematics into mathematics education was examined, it was noticed that it had an affluent past with its affective-related research studies (e.g., Clark, 2006; Gürsoy, 2010; Marshall, 2000; Oprukçu-Gönülateş, 2004; Percival 1999, 2004; Sullivan, 2000). There were studies focused on prospective mathematics teachers' attitudes and beliefs related to the use of history in mathematics education. Oprukçu-Gönülateş (2004) could not found a significant change in prospective mathematics teachers' attitudes towards the method after an intervention, and based this upon the claim that their attitudes were already positive. The prospective teachers stated that the approach would be more appropriate with motivational purposes rather than conceptual purposes. On the other hand, Gürsoy (2010) detected a change in positive way in prospective mathematics teachers' attitudes and beliefs towards the approach with an implementation in the undergraduate course on the history of mathematics. Even though the existence of many researches mentioned, it was clear that there was also a need for a new comprehensive study aimed to generalize its results to a great population which embraces prospective teachers in all undergraduate years of enrollment. It was a necessity that examining the possible effects of gender and year of enrollment on prospective teachers' attitudes and beliefs towards the use of history of mathematics in mathematics education when the related research was considered. Thus, this study aimed to give ideas about what Turkish prospective teachers believe and how they would act towards the history integration into mathematics education, whether there is a difference in their so-called beliefs and attitudes with respect to gender and year in program, and what they know about the history of mathematics which were limited to the curriculum that they were responsible for, whether gender and grade level create a difference or not in their knowledge of history of mathematics, and finally if there would be a possible relationship between their attitudes and beliefs in question and their knowledge of the issue.

The incorporation of history of mathematics into mathematics teaching and learning is a hot issue in the context of Turkey as mentioned before. The achievement tests which can measure the knowledge of history of mathematics related to upper elementary mathematics education (K6-8) were very limited in Turkey. Though the existing relevant research gained the attention for the necessity of prospective teachers' usage and integration of the history of mathematics in their future career in Turkey, to what degree they already have mastered the history of mathematics was not investigated yet. Thus, the study also intended to present a needed reliable and valid measurement tool (KHM Test) to the literature. After it was detected that there was a need for a test measuring what Turkish prospective teachers know about the history of mathematics, the instruments on an attempt to measure their attitudes and beliefs towards the use of history of mathematics related to mathematics education, which they would be offering in the future and they were being educated in the undergraduate programs, were searched. Because of the fact that the existing instruments in Turkish language on the issue (e.g., Gürsoy, 2010) were not constructed based on the actual widespread literature of the field, it was seen as a necessity to build up an instrument, which is valid and reliable, (Attitudes and Beliefs Questionnaire towards the Use of History of Mathematics in Mathematics Education) in this study. The foreground of the two sub aims of developing the instruments at issue was the actual aims of the study, which is to get ideas about Turkish prospective teachers' attitudes and beliefs towards the use of history of mathematics in the teaching of mathematics and their knowledge on the mathematics' history.

### 1.4. My Motivation for Conducting this Study

Personally, I have been in a variety of classroom ambiances from my school experiences as a student in Turkish educational system in primary and elementary grades. To the extent of my observations, I am able to say that the mathematics courses have mostly been fearsome, uninteresting and nonessential to some students who cannot be ignored. Those students consider mathematics just as a school subject formed of things such as numbers, symbols, operations, computations, and graphs isolated from their daily life; as a branch of science which had a permanent structure with its certainty, and not to be discussed and changed. They also tend to perceive it as a collection of knowledge which has already existed since long years, and as a discipline enclosed in its own. These kinds of negative attitudes and beliefs towards and strict perceptions about such an admirable scientific discipline have been stimulating me about interrogating the possible underlying reasons and looking for the ways to revise them.

A book titled *'Dünya'yı Değiştiren Beş Denklem' (Five Equations That Changed the World: The Power and Poetry of Mathematics)* (Guillen, 1995/2006) then confronted me when I was an undergraduate student, or rather an elementary mathematics teacher candidate. The book briefly mentioned about the five milestones accompanying the five great scientists who were the leading actors. It was a riveting book which has had an actuator impact on me for being interested in, and thus motivated to learn more about scientific disciplines. I proceed to read different books about the developments in science and mathematics. As a future mathematics teacher affected by these books, I asked questions such as: Are the students' negative feelings possible to change when they meet such historical events? Are there any ways to include them into the formal teaching and learning process in schools? These two main questions have evolved through my undergraduate and graduate years. I profoundly started to find out some support from the literature, and I succeed.

Consequently, I determined to study the affective aspects of using history of mathematics as an alternative approach to the teaching of mathematics. Personally I thought that including the historical background of some mathematical concepts and/or teaching them as completely integrated with their history may have some positive effects on elementary students' attitudes and beliefs towards the learning of mathematics and mathematics as a scientific discipline. But the attitudes and beliefs in question are not developed spontaneously of course; I believe that the quality of instruction is the core element affecting them, so the mathematics teachers are in the leading role. They should be open to learn some about how to use the history of mathematics for their professional repertoire. This repertoire is greatly likely to take shape in their pre-service training, and their affective viewpoints about how they are going to teach mathematics as well. Thus, I particularly aimed to have an idea about the place of the historical methods of mathematics instruction in their repertoire via measuring their attitudes and beliefs towards the approach and testing some basic knowledge of history of mathematics.

# CHAPTER 2

# REVIEW OF THE LITERATURE

The broad review of the literature, which formed the basis of this study and its impetus, on the field of the inclusion of mathematics' history in its learning and teaching is introduced in this chapter in six major parts: the incorporation of history of mathematics in mathematics teaching, the inclusion of history of mathematics in national policies and practices, prospective elementary mathematics teachers' repertoire on mathematics teaching profession, attitudes and beliefs in the context of the use of history as a teaching method, the relationship between the prospective teachers' knowledge of history of mathematics and attitudes and beliefs towards the use of history of mathematics in mathematics education, and the gender-related issues in the use of history in mathematics education. Finally, the summary of these six parts is presented.

## 2.1. A Past-Originated Teaching Method for Modern Mathematics Education

The idea of that the antecedents of mathematics should be incorporated in mathematics classroom is not new; it has been endured by the beginning of the millennium (Fried, 2001). Even though it was a well-established subfield of educational research and practices in mathematics, there was not a remarkable struggle in giving a definition of this area.

Considering that there is not a direct definition of the historical teaching approach in mathematics education, it can be mainly described with the help of its prominent characteristics. The use of history of mathematics as a natural component of the discipline is an alternative to a variety of different methods of mathematics teaching. It shows mathematics as a human activity to students, enriches their mathematical and interdisciplinary understandings, points out that the development of mathematics has been contributed by different cultures by means of original or secondary mathematical texts for the learning and teaching of mathematics (Fauvel & van Maanen, 2000; Freudenthal, 1981; Heiede, 1996).

When the existing research studies on the integration of history of mathematics with the teaching of mathematics are surveyed, the method seems to be employed in a large scale of mathematics instruction starting with kindergarten to university years (e.g., Charalambous, Panaoura, & Philippou, 2009; İdikut, 2007; Jankvist, 2010; Smith, 1919). The former studies of mathematics can be employed for getting knowledge related to the mathematical concepts, mathematical problems, daily life mathematics, interdisciplinary aspects of the discipline, and the milestones of world history (Siu, 2000). Students may be given the opportunity to reexamine these old works to the end that they look at mathematics topics from a mathematician's perspective. The teaching and learning process then might be turned into a productive attempt for doing mathematics.

History of mathematics also may be a source of inspiration for ordering the teaching of mathematical concepts and topics. This common opinion withstands the most prominent theory associated with this endeavor. The theory was set by Ernst Haeckel in 1874 by the Latin phrase “ontogenesis recapitulates phylogenesis” (as cited in Furinghetti & Radford, 2002). The term ‘ontogenesis’ refers to the evolution of an organism from the impregnating of an egg to its becoming an adult. This single organism can also be thought as an individual. ‘Philogenesis’ means the ontogenesis of the entire species. This theory was used in several different fields of education such as language development in a child (Slobin, 2004). The theory was also adjusted for the field of history use in mathematics learning by Furinghetti and Radford (2002). Jankvist (2009) interpreted it for this field very clearly as “To really learn and master mathematics, one’s mind must go through the same stages that mathematics has gone through during its evolution.” (p. 239).

### 2.1.1. History in Mathematics Teaching and Learning: Is It Necessary and Important?

When the discipline of mathematics is being taught, discussed, or made, one does not just focus on its current position. In addition, mathematics has a past and a future. In respect of Siu’s (2000) viewpoint, the trilogy of past, present, and the future of mathematics should not be separated due to their close interrelation. Heide (1995) supported bringing the history of mathematics as an inseparable part of it into mathematics classroom with the thoughts that learners are given an opportunity to make critical arguments about the past and the present versions of the mathematical topics. Presenting the historical background of mathematics gains students' attention to the significance of the discipline. He also added that the lack of students' interest and their fear of mathematics aroused from not stressing the importance of mathematics enough. Though this claim seems to be assertive, it may be suggested that making students notice the significance of history of mathematics using an effective historical method can overwhelm their interest of mathematical issues.

Swetz (2000) also introduced ideas on mathematical pedagogy that appeared in former mathematics studies. Some examples of these ideas are the usage of visual and/or concrete materials and representations (e.g., Euclid's masterpiece known as *Elements*), ordering the solutions of mathematical problems according to a certain educational intention (e.g., problems in a linked order in the Rhind Papyrus), and arranging the topics in certain sequences (e.g., visual proofs of Pythagorean theorem in the old papers of Greek mathematics). The idea that history of mathematics may be useful to organize mathematics teaching owes arises through its clarification of the past pedagogy of mathematics. In addition, Avital (1995) claimed that it was possible to find antique teaching methods, materials, and the like which may be more appropriate and advantageous to utilize in mathematics classroom practices.

Freudenthal (1981) asserted that students should be able to connect their knowledge in mathematics with other fields like physics, chemistry, biology, and social sciences. One of the ways of this integration can take place may be through the history of mathematics. It can be also useful for making interconnections in the mathematical concepts themselves (Gulikers & Blom, 2002). Freudenthal (1981) also suggested that presenting some historical information during the mathematics classes could be a short break for students. When they tired or bored from the lesson, they should be enthused by the instructor. This might be important for preventing the decrease of their learning motivation. Relating the biographies of mathematicians (Furinghetti & Radford, 2002) may be an instance for such usage.

The history integration to classroom mathematics may give students a chance to broaden their thinking habits, thus they are likely to be reinvigorated from rigidly studying or doing mathematics (Furinghetti, 2000). Looking from the historical aspect to mathematics also may give one chance to see a better and more vivid image of it (Siu, 2000). For instance, it must be grasped that mathematics was done for its own sake as well (Gulikers & Blom, 2002). All members in mathematics education should see that mathematical concepts or issues were not the only topics with which they were familiar (Bagni, 2008). The paths to achieve the final versions ought to be noticed by those who are central to mathematics teaching and learning (Gulikers & Blom, 2002).

Making students more knowledgeable about history of mathematics and the historical development of mathematical concepts is also likely to influence their mathematical understanding in an affirmative way (Freudenthal, 1981; Tzanakis & Arcavi, 2000). Making use of history of mathematics is believed to enable learners to notice that mathematics is a universal product, which has taken contributions of different cultural contexts from all over the world (Furinghetti & Radford, 2002). When students realize this characteristic of mathematics (being common product), they might enquire whether a contribution from their culture exists. If they can find satisfactory information that their own culture also makes some contributions to mathematics, their esteem about their country may increase to a degree (Gulikers & Blom, 2002).

Jones (2004) collected the reasons for benefiting from history in mathematics education with three categories; chronological, logical, and pedagogical ones. The chronological reasons were about the necessity of clarifying the historical facts such as from where zero came from. They are the trumps of skillful and informed teachers in order to encourage possible discussions about these kinds of facts in mathematics classroom. The second one seems not to be connected with mathematics' history directly; it is about how history of mathematics can make a great contribution in improving the logical insights of the students. For example, the logical insights can be developed by helping learners understand axiomatic systems. Lastly, the pedagogical reasons are basically built on the view that Haeckel's (as cited in Furinghetti & Radford, 2002) genetic approach should be used to determine a good pedagogical order and good teaching tools.

In addition to the possible advantages, usefulness, and the other characteristics of the history of mathematics inclusion, one ought to be careful about some of its potential negative effects to students' grasping of mathematical topics and concepts. In concern with this issue, Heiede (1996) pointed out that teachers should be careful about a possible unintended or intended distortion of the history of mathematics in the course of its integration or inclusion into mathematics lesson.

Unfortunately, it is also likely to make the learning of mathematics more sophisticated for students with an improper history of mathematics usage. Related to this issue, it gained attention in the literature that the approach might be inappropriate for younger students due to the idea that they did not catch the historical relevance and had difficulties in grasping the old and strange mathematical methods and thoughts (Gulikers & Blom, 2002). Another negative point may be anachronism, which can be described as using the old and respectively new mathematical symbols and/or procedures together in the same representation. This was beholden as an undesirable consequence in the utilization of the approach (Heiede, 1996). In addition, the necessary resources such as how to use the method or concrete historical materials for classroom practice should be adequate and appropriate (Gulikers & Blom, 2002). From the time aspect, Fried (2001) indicated possible difficulties from the lack of time based on the number of topics that were required to be taught in a certain time (Swetz, 1995).  Fried (2001) also remarked that some issues in mathematics did not have their provisions in present mathematics, thus there was no need to bring them into the mathematics classroom for the only sake of using history of mathematics.

### 2.1.2. How to Set History of Mathematics in Mathematics Instruction

In the ICMI Study *History in Mathematics Education* (Fauvel & van Maanen, 2000), which was one of the major guiding sources for those who intended to know the field with its theory, practice, and research, various ways of the history usage were presented as historical snippets, research projects based on history texts, primary sources, worksheets, historical packages, taking advantage of errors…, historical problems, mechanical instruments, experiential mathematical activities, plays, films and other visual means, outdoors experiences, and the world wide web (Tzanakis & Arcavi, 2000). These ways of history integration were defined and exemplified briefly below.

Historical snippets can be described as factual information which was given in textbooks of mathematics courses (Tzanakis & Arcavi, 2000). An example for this usage may be premier mathematicians' biographies which were given for the aim of pointing out that mathematics is a human struggle or that women also contributed to mathematics (Gulikers & Blom, 2002). Research projects based on history texts are extensive works on the discipline of mathematics conducted through historical viewpoints by students in various levels of education (Tzanakis & Arcavi, 2000). A project by undergraduate mathematics students which investigated how physics affected the mathematical evolution of differential equations (Kjeldsen & Blomhoj, 2009) can be given as an example. Primary sources of mathematics refer to the original works of mathematicians in their own, translated, or adopted forms. Making prospective mathematics teachers study and discuss Euclid's Elements in order to notice the initial forms and core ideas of present school geometry might be one of the practices of this kind (Furinghetti, 2000).

Worksheets can be designed to reinforce an already learned mathematics subject or to make learners grasp a new topic, which was built on the previous related topics. This can be by a step by step method in or out of the classroom environment with a historically supported way (Tzanakis & Arcavi, 2000). For instance, a worksheet developed for primary students might require them to transfer modern number system of decimals into antique Mayan numerals in vigesimal (base-20) number system for the aim of enabling them to grasp the manner of number systems (Lara-Alecio, Irby, & Morales-Aldana, 1998). Historical packages refer to educational program-based teaching equipment connected to precise mathematical topics (Tzanakis & Arcavi, 2000). Taking advantage of errors, alternative conceptions, change of perspective, revision of implicit assumptions, intuitive arguments which were originated in the past of mathematics might be used in the pedagogy of mathematics embedded in a carefully planned teaching session (Tzanakis & Arcavi, 2000).

Historical problems are the problems coming from the past which could not be solved, could be hardly solved, or had different elegant solutions, and had a specific importance in the appearance of a sub domain in mathematics (Tzanakis & Arcavi, 2000). For example, the case of measuring the circumference of the world in respect of Al-Bruni’s viewpoint can be resolved and discussed with the intent of improving mathematical interpretation, implementation, and learners’ interest (Savizi, 2006). Mechanical instruments are the tools that work for delineating mathematical proofs and visually presenting some certain mathematical topics with their integral elements (Tzanakis & Arcavi, 2000). The pantograph is an example of such a mechanical instrument. The Laboratory of Mathematical Machines of Modena had such historical didactical instruments (Bartolini Bussi, Taimina, & Isoda, 2010).

Experiential mathematical activities addresses for the recurrence of mathematical activities from the history of mathematics in today's mathematics classroom (Tzanakis & Arcavi, 2000). Sertöz (1996) presented an example for this use by calculating the approximate value of pi number with the help of a drawing a circle on a beach, then using a rope for finding the value.

Plays mean some role playing activities like drama in which an issue in mathematics is presented (Tzanakis & Arcavi, 2000). Kotarinou, Stathopoulou, and Chronaki (2011) conducted an example study for this kind to show a process from the definition of the 'meter' during the French Revolution. Films and other visual means which reflect an historical point or process can be used for enlightening the discipline from the aspects of being human production, social and cultural endeavor (Tzanakis & Arcavi, 2000). As an example, a documentary by Turkish Radio and Television Corporation (TRT) in 1994 named as *The Bright World of Mathematics (Matematiğin Aydınlık Dünyası)* dramatized some of the important events among the historical development process of the discipline for the aim of clarifying the human aspects of mathematics, the power of mathematics, and mathematics in daily life (TRT, 1994). Outdoors experience corresponds to engaging learners in some activities outside the routine learning experiences in their school life like walks in natural environments to notice mathematical structures and visits to museums related to science in order to see the improvement of our lives thanks to the works of scientists (Tzanakis & Arcavi, 2000). The world wide web, or commonly known as the internet, can also be useful in the attempt of using history in the teaching and learning of mathematics (Tzanakis & Arcavi, 2000). As an example, creating an in-service training environment on the issue of the history of negative numbers for mathematics teachers may be suggested.

In addition to the presented aspects to the integration of history into mathematics education, Siu (2000) claimed under four components considering the purposes of integrating history in the undergraduate degree, which were the ABCD of history integration to mathematics classes. This approach may be utilized in the pre-service training of mathematics teachers as well. He used the 'A' for 'Anecdotes', 'B' for 'Broad outline', 'C' for 'Content', and 'D' for 'Development of mathematical ideas'. In brief, he claimed that didactical anecdotes related to the mathematics topics can work as an accelerator for the learning of that topic by means of their memorable and funny characteristics with their important instructional messages with 'A'. He addressed the fact that an history based summary related to the mathematical issue or course could increase learners readiness or digestion of that issue or course, make them ready to link the new learning with that learned previously with 'B'. He supported the idea that utilizing topics from the history of mathematics in mathematics courses may improve students' learning with 'C' and he used 'D' on behalf of the investigation of history of mathematics for students' development of the ideas of mathematics via the original sources. For example, noticing that geometry is not consisted of just Euclidean geometry can be returned to students by the latter aspect of Siu's (2000). As it can be seen, the categorizations about the ways of using history of mathematics vary due to the researchers' perspectives.

## 2.2. The Inclusion of History of Mathematics in National Educational Policies and Practices

If one asks where can be the commencement of incorporating history in the actual mathematics classroom, one can reply that the starting point will be mathematics curricula being followed in the majority of the countries. Experts in the research field of using history in mathematics education, mathematics educators, historians of mathematics, mathematics teachers, and students should jointly take part in this crucial installation process. Heiede (1996) stated that changes in the curricula under discussion ultimately reflect themselves in the textbooks of school mathematics. He continued with the opinion that mathematics teachers should also be given the opportunity to learn how to use history of mathematics in mathematics education via books on the matter. Fasanelli et al. (2000) claimed that although several countries have been using the history of mathematics in a variety of levels, their curricula and practices should be changed and reformed considering the recent research regarding mathematics teaching and learning.

One of the countries in which history of mathematics utilization is stressed in a high degree is Denmark (Gulikers & Blom, 2002). Denmark increased the efforts for the history integration in the curriculum via expressing that learners of mathematics could master some knowledge on historical development of mathematics discipline and link this knowledge with scientific progression in other branches of science and advancements in humans' social and cultural life (Jankvist, 2010). Helping students achieve these purposes became obligatory for teachers of mathematics (Fasanelli et al., 2000). Heiede (1996) also introduced that dealing with mathematics from an historical perspective, which enables students to gain some key historical knowledge connected with community and culture about the discipline of mathematics, contained certain mathematics teaching aspects in Danish mathematics curricula. Students were expected to make the connection of history of mathematics via project works (Fasanelli et al., 2000). Summer courses informed and educated the teachers on this issue (Heiede, 1996). However, it was necessary to add that using history of mathematics in mathematics learning was mostly started from upper secondary students and ended with undergraduate or graduate students since it was thought it was necessary for their professional development or their special interest in the history of mathematics or its integration (Fasanelli et al., 2000).

Another prominent example about the history integration is China. The main aim of the incorporation was different than Denmark. With reference to Fasanelli et al. (2000), the prime reason was in stimulating students to develop and improve the nationalist ideas. This reason also appeared clearly in the mathematics curricula of the country. A series of inventions and discoveries in mathematics were renamed considering their parallel development in ancient Chinese mathematics texts or their counterpart Chinese owners. The researchers of mathematical education naturally directed their interests into using history in mathematics education, but there were some problems and/or deficiencies in the implementation process such as historical anachronism (Heiede, 1996). The history usage also came up in the training of mathematics instructors or graduate students of mathematics education (Fasanelli et al., 2000).

In Argentina, Israel, Japan, New Zealand and the UK, it might be said that the history of mathematics was not sufficiently presented in mathematics education (Fasanelli et al., 2000). In Italy, the incorporation was well established like in Denmark. There was a multiplicity in this issue in the USA since each state followed a different policy in the teaching of mathematics.

### 2.2.1. The Upper Elementary (K6-8) Mathematics Education in Turkey in Connection with the Incorporation of History of Mathematics

The upper elementary education for 12-14 years old students is obligatory in Turkey since 1997 (MoNE, 1997). Public schools give this compulsory education free for all citizens of the Republic of Turkey (MoNE, 1983). The learning of mathematics plays an important part of this three yearly education process. In the last version of the radically reformed elementary mathematics curriculum, the prevailing aims of the mathematics education stressed that students should:

- learn mathematics conceptually and meaningfully in relation with different domains of knowledge and daily life,
- develop positive attitudes towards mathematics,

- notice and thus appreciate the power of mathematics and its close relation to other branches of science,
- develop and improve an intellectual interest in the discipline,
- interrelate the mathematics with art, and develop aesthetical emotions,
- grasp the historical evolution of mathematics in parallel with its significance in the development of human thought and the importance of its utilization in other fields of science (MoNE, 2005).

When these purposes were overviewed, it may be inferred that they match with most of the reasons of using history of mathematics in the instruction of mathematics which was examined in the related literature.

Considering the revisions of the curriculum and its reflections on the implementations (Durmuş, 2010a, 2010b, 2010c; MoNE, 2005), pre- and in-service training policies and applications (HEC, 2007; MoNE, 2010), and studies related to the use of history in mathematics education (Baki & Güven, 2009; Bütüner, 2008; Gürsoy, 2010; İdikut, 2007; İlhan, 2010; Kar & İpek, 2009; Karakuş, 2009; Oprukçu-Gönülateş, 2004; Tözlüyurt, 2008), it may be mentioned that the concern about making use of history of mathematics in Turkish educational system originated in the recent decade, and it increased remarkably during recent years.

In the light of an examination through the revised form of the Turkish elementary mathematics program for the upper-elementary schools (MoNE, 2005), it was evident that the history integration into the process of elementary students' learning of mathematics was included. The initial signals of the inclusion were given among the purposes of the program as "…it intended to make students able to comprehend the historical development of mathematics in parallel with its importance and value in the development of human thought, and the significance of its usage in other fields." (MoNE, 2009, p. 9). The inclusion was supported by suggestions on how to use the history of mathematics in different learning areas in each year of the three yearly stages. In Table 2.1 the suggestions for the history of mathematics in the program are presented.

Table 2.1

*The History of Mathematics in Turkish Elementary Mathematics Curriculum*

| Grade Level | Learning Areas | | |
|---|---|---|---|
| | Numbers | Probability | Measurement |
| 6th grade | History of money related with mathematics | | History of measurement |
| 7th grade | History of rational numbers | History of probability | |
| 8th grade | | | Historical pyramidal buildings and their volume in the learning area of measurement |

In addition, it was suggested that measurement could be studied in relation with the branch of history. The origins of mathematics also gained attention among the sample topics of student projects with the subtopics of mathematics in different cultures, the historical development of mathematics (e.g., Mayan numeral system, and fractions in ancient Egypt), the life of those who contribute mathematics (e.g., Atatürk, Pythagoras, Thales, and Escher), the history of mathematical games, and origami (MoNE, 2009).

The notable inclusion mentioned above was also manifested itself in the official textbooks in which isolated historical factual information such as names of important persons in mathematics or mathematics education, old symbols, and short stories from the past of some topics was presented. More precisely, the place of such historical data is given in Table 2.2 in the next page.

Table 2.2

*The History of Mathematics in the Official Textbooks of Turkish Elementary Mathematics Education*

| Learning Areas | Grade Level | | |
|---|---|---|---|
| | 6th | 7th | 8th |
| Algebra | Fibonacci’s problem about the birth of rabbits | | |
| Geometry | Teaching activity with tangram | History of pi number | Student projects about geometricians; historical origins of triangle concept in new Turkish republic; triangles in ancient Egypt; Pythagoras |
| Measurement | | | Surface area of a pyramid with Keops in Egypt, a problem on right circular cone with Süleymaniye mosque |
| Numbers | Presentation of Egyptian numeral system | Story and necessity of numbers and their cumulative structure | History of the square root symbol |

The historical enlightenments placed in Table 2.2 were mostly located in the introductions of new units, topic, or subtopics or units.

### 2.2.2. History of Mathematics Integration in the Context of Turkey

In parallel with the reform in the elementary mathematics curriculum (MoNE, 2005), undergraduate programs which trained future elementary mathematics teachers made some revisions. In the literature, it was written that new courses and workshops on the use of history in mathematics education can be designed for training the teachers (Heiede, 1996). This suggestion was embraced in the mathematics teacher education policies in Turkey. A tangible example for these revisions may be the appointment of certain courses associated with history in mathematics education. These courses were History of Science, History of Mathematics, and Philosophy of Mathematics courses (HEC, 2007). But there was not a course directly on the use of history in elementary mathematics education yet. Prospective teachers' training in history integration seemed to be depending on university teachers' initiatives and special interests on the matter. As for in service training for elementary mathematics teachers, the Ministry of National Education started an enterprise on the education of mathematics teachers about use of history of mathematics under their own training programs (MoNE, 2010).

Several studies in Turkey reported how history integration was employed in certain settings (e.g., Bütüner, 2008; Hacıömeroğlu & Apaydın, 2009; İlhan, 2011; Kar & İpek, 2009; Karakuş, 2009). These studies were mostly for the instruction of mathematics topics taught in elementary grades.

An experimental study in which prospective mathematics teachers participated combined the old and new techniques in mathematics learning (Baki & Güven, 2009) on the purpose of enabling the future teachers to notice some social and cultural aspects of the discipline. The prospective teachers in this study were taught how to solve one form of cubic equations using Khayyam's method. The method then was checked and new methods for the same cubic equation used by the students themselves. The study indicated that both dynamic geometry environment and the history of mathematics were seen as profitable alternative ways for learning mathematical concepts.

The review of the Turkish studies on the history integration showed that there was not much attempt for using history in mathematics education. About the nature and content of the existing studies it may be suggested that associating with the elements of affective domain like attitudes, beliefs, and views were the common characteristic of the broad studies. The affective positions towards the use of the history in mathematics teaching and learning or towards the possible affective effects of this usage on different people in mathematics teaching (students, pre- and in-service teachers) towards the course of mathematics were examined. Some applications for different grades were implemented in these studies. Qualitative research methods were occasionally used to understand deeply the predispositions of the participants. The participants were mostly future mathematics teachers. The unimplemented draft plans for the incorporation were primary and elementary students' mathematics lessons, but their utility was still a question mark. Lastly, the lack of the studies on the issue conducted with the participation of in-service mathematics teachers was probably the most remarkable point in this comb of the literature.

### 2.3. The History of Mathematics in Elementary Mathematics Teacher Candidates' Repertoire

According to Hiebert and Grouws (2007), the nature of instruction given in mathematics classroom had a considerable impact on students' learning of the subject. In what follows, the significance of the role of mathematics teachers cannot be ignored since they constitute a key component in this teaching-learning process. In respect of McBride and Rollins's (1977) viewpoint, being able to integrate history of mathematics into mathematics lessons should also be one of the components of mathematics teachers' repertoire. Among the reasons of the resistance to the inclusion of history of mathematics in mathematics class, it was raised that teachers did not have the required background on the use of history under consideration and this case was attributed to their pre-service teacher education (Gulikers & Blom, 2001). Because of the fact that prospective mathematics teachers' are going to take the mission of educating students in mathematics in the future some important points about mastering the history of mathematics usage in mathematics' teaching process were attempted to be displayed in the following subheading for the professional development of future mathematics teachers.

Among a variety of teacher characteristics which have a potential to affect students' learning (Hiebert & Grouws, 2007), the knowledge that they possessed related to the pedagogy of mathematics took an integral part. Sowder (2007) forwarded her ideas about this matter as follows "…the key to increasing students' mathematical knowledge and to closing the achievement gap is to put knowledgeable teachers in every classroom." (p.157) At this point, it should be stated that this study is interested in a prospective mathematics teacher's characteristics, abilities, and skills regarding his/her professional repertoire and proficiency in different teaching approaches. These methods can be efficiently used separately or together in the future. The underlying reason of this interest was that just one approach to teaching could not effectually meet the entire learning goal kinds (Hiebert & Grouws, 2007). This situation might also be attributed to the common idea that each student has his/her own learning style. Because of the arguments and opinions under consideration, it can be suggested that the learning environment in a mathematics classroom should be as much interesting as possible in respect of various approaches that mathematics teacher brought to his/her teaching.

Sowder (2007) introduced mathematics teachers' knowledge about the pedagogy of mathematics among the aims of the professional development. From this point of view, it may be claimed that they ought to be trained for the aim of mastering the pedagogical content knowledge better in the pre-service leg of their whole professional development. Moreover, teacher candidates' knowledge regarding the curriculum that they are going to utilize in their future teaching took a crucial place in this process of development (Shulman, 1986).

Mathematics student teachers should be inquisitorial about the content that they will teach and how to present this content at the same time. Suspecting something and interrogating it is not likely to occur if they are not proficient about the knowledge related to their instruction. This is the thing that dogmatic people do (Siu, 2000). Prospective teachers' competence in professional knowledge of mathematics teaching may be considered important due to Heiede's (1996) opinion that instructors should not trust blindly to writers of textbooks or other authorities.

As being knowledgeable and having a wide repertoire related to mathematics teaching has so much significance in mathematics education, the necessity of assessing these issues should not be disregarded. These assessments provide information about what is lacking and thus need to be improved in teachers' knowledge related to their instruction (Hill, Sleep, Lewis, & Ball, 2007). With reference to Kagan (1992), it is possible to suggest that relevant feedback should be given to teachers of mathematics with the aim of correcting their possible misunderstandings and misinterpretations after such an assessment procedure. In this context, assessing mathematics teachers' knowledge in every step of the prospective training may be required in order to make them ready before the actual teaching experiences.

In parallel with Fried's (2001) idea that one should know history of mathematics adequately before integrating it, prospective mathematics teachers are desired to know the origins of mathematical topics that they teach if they are expected to include the use of history in their professional qualifications. The term ‘mastering’ does not mean that they should be perfect or showing a marvelous performance on the matter. It is so natural for them to stumble in the voyage to the history of mathematics when they are teaching mathematics because their profession is not historiography of mathematics (Heiede, 1996). But, it is necessary for them to create accurate and sufficient basic background knowledge about the history of mathematics related to mathematical concepts or topics that they will be responsible for teaching in their career.

Those who are going to use the historical origins of mathematics ought to protect themselves from imprudently approving the appropriateness of presented ways of the history utilization (Heiede, 1996). To give some examples, the appropriateness here might be spoiled by allowing for the historical anachronism, sticking with just one source of history of mathematics, misinterpretation of the original sources of mathematics, benefiting from secondary sources that distorted some realities about history of mathematics. Additionally, Fried (2001) suggested that those who are interested in studying history in mathematics education ought to consider whether an historical part is pertinent or not to the whole usage.

On the essentialness of learning history of mathematics for those who have an affinity with the subject, Freudenthal (1981) stated that “People who study mathematics choose it (studying history of mathematics) because it represents solid knowledge, dependable knowledge, theorems one can prove, definitions with consequences proofs one can understand.” (p. 31). It can be inferred from this statement that prospective mathematics teachers, who are going to have the special mission of teaching this subject in the future, also need to be knowledgeable about history of mathematics for better grasping the disciplinal structure of mathematics.

Among prospective mathematics teachers, those who are a stranger to the use of history in mathematics education ought to be under special attention. It is so natural to agree Heiede's (1996) idea that instructors of mathematics who were studied mathematics with non-historical methods of teaching for their whole educational life should be professionally trained in order to improve their history of mathematics background, and their proficiency to use this in their own mathematics teaching.

With reference to Philippou and Christou (1998), prospective teachers in Europe have some difficulties in their motivation to learn and teach the subject. Teacher candidates from other parts of the world might be suffering from the similar difficulties. Thus, it can also be suggested that educating mathematics teacher candidates in history of mathematics might show some secondary positive effects like gaining motivation to teach mathematics. The potential of making prospective teachers see and discuss the historical original sources of the mathematical knowledge that they know from modern textbooks may be added to these positive effects as well.

The existing studies in the literature with the aim of measuring knowledge of history of mathematics were limited to a degree, and they were conducted precisely for different country contexts. Goodwin (2007) looked for a possible correlation between high school teachers' knowledge of history of mathematics and how they image the discipline of mathematics. In the study, more knowledgeable teachers on the history of mathematics stated that learning mathematics was not mastering some factual information and procedure, it was about rediscovering mathematics. They also stated that mathematics was not just done by mathematicians, that it was perpetually developing, and it reflected several cultural mosaics. Relatively less knowledgeable teachers asserted that the discipline of mathematics was formed of absolute laws and fixed ideas, and only private individuals were able to do mathematics.

Because of the arguments discussed above and the lack of the already conducted studies, educators compromised on the belief that both future and present mathematics teachers should be equipped with the mentioned requirements of the alternative teaching method namely using history in mathematics teaching (Heide, 1995). This might also be seen the greatest reason for the ongoing effort of research studies examining how teacher knowledge has an effect upon their mathematics teaching (Philipp, 2007). But, being knowledgeable about history of mathematics may be deficient for utilizing it in mathematics instruction. The affective approach of future mathematics teacher can be the enactor. This approach was examined via the concepts of attitudes and beliefs in this study. Thus, the issue was maintained with the review of the literature on attitudes and beliefs in relation with the use of history of mathematics.

## 2.4. Attitudes and Beliefs in the Context of the Integration of History of Mathematics

This section primarily focuses on the terms of attitude and belief in several studies. Then, the significance of the attitudes and beliefs related to mathematics education was discussed both for pre- and in-service mathematics teachers. Lastly, the studies that investigated the integration of history of mathematics from affective aspects with mathematics teachers are discussed.

### 2.4.1. The Terms Attitude and Belief from Different Aspects

In Richardson's (1996, p. 103) viewpoint, the term belief was defined as "psychologically held understandings, premises, or propositions about the world that are felt to be true." On the meaningfulness of the pointed insights and overtures, Gilbert (1991) emphasized that one initially should be knowledgeable about an issue to have an expressive belief regarding that issue. Beliefs that one possesses are specific to him/her and are resistant for change (Pajares, 1992). It may be synthesized considering these statements that prospective mathematics teachers' beliefs related to mathematics instruction addresses their inner remarks and the echoing of these remarks to their ideas and expressions about the correctness or fallacy of a phenomenon, which is relevant to the various elements of their future mathematics teaching, based on the existing knowledge about that phenomenon. To set examples, the beliefs may be appertaining to the nature of mathematics topics as a scientific branch, their own efficacy on teaching the mathematical subjects, several instructional approaches regarding mathematics education, and the usage of these approaches.

Among a large spectrum of prospective teachers' beliefs about their future profession, this study focused on those related to a special method of teaching mathematics and how it is practiced upon in the mathematics classroom. This approach is the integration of history of mathematics into mathematics education. Prospective teachers' beliefs towards the use of history referred to their true-false judgments about the usage that they created in their mind after getting to know about it. Their representation of these positive or negative beliefs may be assembled under some aspects such as the practicality of the approach, its affective or cognitive effects on students' learning of mathematics (e.g., İdikut, 2007), and benefitting from it in pre-service teacher training (e.g., Philippou & Christou, 1998).

At this point, it was found essential to give a place to one specific belief type, which is self-efficacy belief, because of the fact that it took part in some items of the data collection instrument used in this study. Self-efficacy belief was defined by Bandura (1997) as "…beliefs in one's capabilities to organize and execute the courses of action required producing given attainments." (p. 3). Personal efficacy beliefs are one's beliefs about his/her thoughts regarding their own confidence on accomplishing foretold missions and/or showing desired skills. In the context of this study, self-efficacy beliefs towards the use of history of corresponds to prospective mathematics teachers' beliefs regarding their self-confidence on accomplishing the foretold missions and/or showing desired skills related to the use at issue in their own mathematics instruction.

Philipp (2007) characterized attitudes as humans' actual or potential behavioral activities reflecting their thinking and ideas on an issue, a situation, or a person. According to McLeod (1992) attitudes "involve positive or negative feelings" (p. 581) such as "liking, disliking, being curious, being bored" (p. 581). Ajzen (2005) addressed that the comprehension of a person's attitude is possible with the evaluation of his/her behaviors and the circumstances under which these behaviors occurred. In another description, it was stated that attitudes are the "… judgments influenced by external information, the memory of past judgments, prior knowledge, and stored new judgments." (Albarracin, Zanna, Johnson, & Kumkale, 2005, p. 3). In addition, Mc Leod (1988) stated that attitudes are permanent and do not change from time to time.

The matter of attitudes also found its place among the research conducted about the instructors of mathematics such as their attitudes towards the discipline (e.g., Matthews & Seaman, 2007) and approaches for students' learning of mathematics (Ernest, 1989). Among the kinds given as examples, this study aimed to contribute to the specific literature regarding the second one. Future mathematics teachers' attitudes towards the history of mathematics usage, which they can consult in their professional life as a useful tool, constitute their latent manners of behaviors related to the various usages of this approach (e.g., Tzanakis & Arcavi, 2000).

According to McLeod (1992), researchers consult the terms of attitudes and beliefs in order to meet several different affective reactions in mathematics education. These two affective components are used together in many studies since they are often considered as two nested phenomena affecting human behavior, they are different affective components indeed (Ajzen, 2001; Goldin, Rösken, & Törner, 2009). Researchers stated that it is problematic to differ whether some studies are about attitudes or beliefs (McLeod, 1992). Individuals sense their beliefs less densely than their attitudes, and they are structured more lasting than attitudes and thus less changeable for an individual (McLeod, 1992; Philipp, 2007). In addition, McLeod (1992) asserted that "attitudes related to liking or disliking" (p. 578), whereas beliefs are less related with senses. He added that the required time for forming these two affective constructs also differs for an individual such that the necessary time for forming a belief is more than that of forming an attitude. This difference is stemmed from that beliefs are settled more strongly in cognitive system of one's mind (Philipp, 2007).

Though attitudes and beliefs are differentiated in the literature, there are some ideas which suggests that these two components are interweaved (McLeod, 1992). Some statements about affect can also be appraised as both attitude and belief expressions (Pehkonen & Pietila, 2003). As an instance for this idea, the 11th item of "I do not have an idea about how to use historical materials." may be given. For a prospective teacher, this statement can be seen as an expression about his/her personal beliefs, but it can be also considered as an attitude expression towards the use of history of mathematics in mathematics education considering Pehkonen and Pietila's (2003) thought.

### 2.4.2. The Value of In-service and Prospective Mathematics Teachers' Attitudes and Beliefs in Mathematics Instruction

Philipp (2007) gave detailed information in his deep review about research on teachers' beliefs for the aim of attracting concerned researchers' attention to the increased popularity and significance of this field. The existing research on beliefs and affect are still trying to find out how these affective factors influencing teachers' instruction. Koballa and Crawley (1985) stated that humans act through their attitudes and beliefs. According to Li (1999), the main underlying idea of studying teachers' education related beliefs can be collected under two components. The first one is that teachers act in classroom in accordance with their relevant beliefs, and the second refers to that their mentioned actions and manners have an effect upon students' attitudes and beliefs towards the subject itself, and thus the learning of that subject. Ernest (1988) also stated that mathematics teachers' beliefs towards the teaching and learning mathematics had an influence on their actual classroom instruction and their choices. Thompson (1992) stated that "Teachers develop patterns of behavior that are characteristics of their instructional practice. In some cases, these patterns may be manifestations of consciously held notions, beliefs, and preferences that act as 'driving forces' in shaping the teachers' behavior" (p. 105) and she added that this relationship is bidirectional. As for attitudes, it can be asserted that behaviors of individuals show parallelism with their attitudes (Ajzen, 2001; Ajzen & Fishbein, 1977; Glasman & Albarracin, 2006; Kallgren & Wood, 1986). Considering this relationship between attitude-belief and behavior, it can be claimed that prospective teachers also expected to display their actions in their future teaching through their attitudes and beliefs become important for their future practice (Richardson, 1996). Still, teachers do not always act through their attitudes and beliefs. According to Thompson (1992), there may be contradictions between their behaviors and attitudes and beliefs due to the environment of the place in which mathematics is being taught and/or classroom experiences. For instance, a mathematics teacher may have high attitudes and beliefs towards the use of a specific teaching method but he/she cannot utilize that method in mathematics classroom because of the lack of necessary guides, textbooks, and teaching materials.

Future teachers are thought to have some certain existing beliefs and attitudes from their pre-college years related to how mathematics can be learned and taught when they enter teacher education (Kagan, 1992; MaaB & Schlöglmann, 2009; Pajares, 1992). According to MaaB and Schlöglmann (2009), the beliefs and attitudes may probably constitute interference for broadening their teaching repertoire with new and alternative ways to teach mathematics. When the thought that teachers' beliefs and attitudes have a natural effect on teaching in classroom (Kagan, 1992), the significance of the tendency to the research with prospective teachers can be grasped better.

About the prospective teacher education programs, Kagan (1992) asserted that revealing teacher candidates' substantial beliefs and discussing about them should be placed among the roles of those programs. She supplemented the idea that the training should also present educational environments for them in order to improve their existing beliefs with new pedagogical knowledge, skills, and abilities gained in this training process.

Li’s (1999) second element of the idea that pre- and in-service teacher beliefs are needed to be investigated can be supported with Philipp’s (2007) ideas. Philipp (2007) suggested that since teachers guide and assist the learning experiences of students, it is natural to expect that they have an important impact on shaping students’ attitudes toward the course and the discipline, and on their beliefs related to the learning of the subject.

### 2.4.3. Studies on Affective Issues on the Use of History of Mathematics in Mathematics Learning and Teaching

There are several studies about how the historical method could affect attitudes towards and perceptions of mathematics, its history, and mathematical topics (e.g., Clark, 2006; Darrow, 1997; Dickey, 2001; Marshall, 2000; Percival, 1999; Percival, 2004; Sullivan, 2000), and also could have an impact on views about mathematics (e.g., Goodwin, 2007).

Related to the possible influence of the history usage in mathematics instruction on learners’ attitudes towards mathematics, Dickey (2001) made an action research, which aims to elicit for giving feedbacks to a local base (Fraenkel & Wallen, 2006), by implementing historical classes on the mathematics topics of numbers and factors with 8th grade students who had just finished their elementary education. After the interventions, it was detected that the learners' thoughts about the discipline changed and broadened to a degree. They preferred the opinion that mathematics is just formed of numbers to that it has much more sophisticated and rich. The new approach was liked by them. The great improvement in the discipline was appreciated, and students thought that learning mathematics became easier. They noticed the indestructible bridge between the past and the present of the discipline. Students were of the opinion that the course indeed could be enthusiastic. The role of mathematics in culture and how it made human life more comfortable and easier was seen. In another research on the matter with students, Marshall (2000) explored change in a positive way in secondary students' mathematics-related attitudes with the use of some historical mathematics problems. They felt more comfortable after the investigation procedure. Mathematics was seemed to be more amusing for them with the experience. The application also gained students' attention to human production characteristic of the discipline.

Goodwin (2007) attempted to find a contingent relationship between high school mathematics teachers' knowledge about mathematics' history and their views of the discipline. A correlation between these two was found to be significant according to the data yielded from 193 high school teachers who were selected via clustered random sampling. Considering the items placed in the used scales, this relation was interpreted by the researcher as the increase of the knowledge of history of mathematics accompanied with the images in which mathematics is a continuous discipline, it can be done by everyone, and it clarifies some cultural varieties during the history. Exploring mathematics is more important than knowing some factual mathematical information like procedures. The participants with insufficient knowledge about the history of mathematics viewed the discipline as the composition of static knowledge of formulas and undeniable information. They added that one should have mathematical ability to achieve in the subject. Additionally, the teachers were found to be somewhat poor in the knowledge about the history of mathematics when the courses and their high interest on the matter were taken into consideration.

In another study conducted with teachers, Clark (2006) focused on the integration of the past of logarithms via a case study conducted with the participation of five teachers of secondary mathematics. One of the components of this research was to examine the teachers' attitudes towards the history usage. Before the implementation, they expressed that they were in favor of the utilization of this teaching method. This positive position did not change mostly during the same process of implementation. According to the responses of teachers to the attitude scale used in the study, it can be forwarded that the use of history of mathematics created a prosperous educational environment, made the lessons funnier, and increased the standards of mathematics instruction. They also agreed that history of mathematics should be a part of their professional training. In another research, Percival (1999) clarified some effects of a history of mathematics inclusion to social studies course for seventh graders on students and teachers. The teachers in this study seemed to be considerably interested in using old resources in mathematics classroom, and they depicted that they should know more about the past of the discipline which they were responsible to teach.

Sullivan (2000) investigated the attitudes towards the integration of the history of mathematics to its teaching. In the experimental study, the first group took a mathematics course supported by history of mathematics, whereas the other took methods of teaching mathematics course. After the experimental process was ended, it was found that the teacher candidates in the experimental group showed more positive attitudes towards the method of mathematics teaching.

The studies about the use of history in mathematics education conducted in Turkey (Gürsoy, 2010; İdikut, 2007; Oprukçu-Gönülateş, 2004; Tözlüyurt, 2008) included certain affective factors. Since they attempted to clarify the mentioned affective effects in Turkey, the findings and results of these were given one by one and in details.

Oprukçu-Gönülateş (2004) studied prospective mathematics teachers' attitudes towards the integration of history of mathematics, took their thoughts and suggestions about the 'hows' of using history of mathematics in mathematics teaching, and what they expected from the inclusion of history of mathematics in mathematics classroom. An implementation of methods of mathematics teaching training supported with the history of mathematics was carried out via article assignments on the usage, discussion of the opinions about these assignments and the possible ways of the history usage, and a round table discussion with brainstorming on the specific and general aspects of the issue. After the implementation ended, the future teachers' attitudes changed in a positive way, but did not change significantly. This result was connected to the participants' pre-existing high positive attitudes. The participants also showed affirmative approach to use this rich source in their future teaching, but they complained about insufficient training in the history of mathematics. Another important point to be clarified among the results of this study was that the prospective teachers found the integration of history of mathematics more appropriate with the aim of motivating students to learning mathematics rather than their conceptual understanding of mathematics. They did think the history integration was part of the routine following of the curriculum (Oprukçu-Gönülateş, 2004). This work also contributed with the development of an attitude scale for the present study.

A similar research was conducted by Gürsoy (2010). Elementary mathematics teacher candidates participated in this study for the aim of determining the effects of a course in which history of mathematics integration was presented and used on their views, attitudes, and beliefs on the use of history of mathematics in the teaching of mathematics. The History of Mathematics course was among the suggested courses by HEC (HEC, 2007). It was conducted with some elementary mathematics teaching activities in which the mathematical concepts were connected with their historical origins. In order to make these connections, the author benefited from certain mathematicians' lives and works, ancient humans' needs to maintain their lives, and old methods' practical applications in modern life. Both quantitative and qualitative methods were used via developed instruments by the researcher. The results of the study indicated that the course positively affected the student teachers' attitudes and beliefs towards the use of history of mathematics in their future mathematics teaching. The findings from the semi-structured interviews revealed that they desired the History of Mathematics to be a course in which using history in the teaching of mathematics studied. They agreed on the thought that the history of mathematics could be employed for developing students' interest to mathematics lessons, for better grasping the actual nature of mathematics, and for enriching the content of the lessons with this different source. İdikut (2007) investigated the effects of a mathematics instruction process supported with the history of mathematics on seventh grade students' academic achievements in mathematics, their attitudes towards the mathematics course, and the stability of their learning of mathematics. In this experimental study, work sheets regarding some premier mathematicians such as Carl Friederich Gauss, Leonardo Fibonaci, Omar Khayyam, and Pierre de Fermat were used as history of mathematics related teaching material. The mathematicians introduced themselves and their works, the courses were studied with their voices. The implementations of the worksheets especially stressed the contributions of different cultures to mathematics, the importance of mathematics in the development of the civilization, and the clear place of mathematics in students' everyday life. The students in the historically supported group did achieve better than those in the control group. However, the same positive effect could not be observed in their attitudes towards the subject and the persistence of their learning of mathematics in the implementation which took advantage of the history of mathematics. Tözlüyurt (2008) conducted a study in order to have an idea about secondary students' views on the history based courses related to numbers learning area. This qualitative research with its phenomenological case study method clarified that the students looked positively to the integration of history of mathematics in mathematics lessons. They were of the opinion that mathematics was a complex subject and it was difficult to understand this subject. But they thought that introducing the history of mathematics made their mathematics classes easier, productive, and more interesting. In the name of the method's contributions to learning mathematics, it was put forward by students that the inclusion of history of mathematics especially would be advantageous in meaningful learning of mathematical theorems and problems. The question of where history should be integrated in a mathematics lesson answered differently by the participants. They also found the use of the approach more appropriate with students in lower levels like elementary and primary education.

## 2.5. The Possible Role of Prospective Mathematics Teachers' Gender on Their Knowledge of History of Mathematics and Their Attitudes and Beliefs towards the Use of History of Mathematics in Mathematics Education

With reference to Gallagher and Kaufman (2005), the variation that gender created in people's education-related skills and behaviors would presumably be less than those produced by other individual factors. Nevertheless, researchers' interest in the domain of research studying gender differences are internationally is increasing (Fennema, 2002). This attention to seek male and females' differences in the mathematics education might be connected to Halpern, Wai, and Saw's (2005) opinion that not examining the real gender variable included data related to the research topic in doubt is likely to cause some speculations and biases on the actual role of gender on that topic. It might be claimed that such kind of prejudgments seems to be unfair without making reliable research studies if the inconsistence of the evidences is considered (Gallagher & Kaufman, 2005). The existing studies lead the way of organizing the educational environment and designing new researches (Fennema, 2002).

Gender type of teachers had an impact on their beliefs towards the preferences that they choose when teaching mathematics (Li, 1999). As an example, female teachers allowing for the classroom environments in which learners study collaboratively supported by affective factors driven by these teachers (Li, 1999). Accordingly, it is possible to assert that being male or female might create some differences in the teachers' opinions about the integration of history of mathematics into mathematics instruction. Despite the fact that teachers are shown as one of the most important components of a mathematics classroom, the studies on their gender related differences were not in a desired degree (Li, 1999). Therefore, teachers should be examined in their undergraduate years in order to be educated on this matter considering the results of similar studies.

The literature regarding the use of history in mathematics teaching and learning showed that gender was included in these studies in a very limited degree, and the social based sex variable was used in analyzing the effects of that method. İdikut (2007) investigated the possible effects of the history of mathematics supported 13 years old students' attitudes towards mathematics and their mathematics achievement by employing an experimental design. The relation of the results to gender was examined for experimental and control groups. It was detected that the experimental process did not affect the students' attitudes towards mathematics in respect of their gender. The academic achievement of the students in the experimental group also did not differ significantly.

As for the studies examined the factor of gender in mathematics-related achievement, the diversity of the findings were remarkable. According to the review comprised 1980s and 1990s by Tate (1997), female students felt behind males with respect to their mathematics performance in standardized examinations in the USA, but these two groups' achievement criteria were fairly close to each other. The mentioned superiority of males to females was likely to emerge especially in high school years (Entwisle, Alexander, & Olson, 1994). The evaluations of the related literature caused other findings. For instance, It was determined that the variations by virtue of gender were decreasing gradually (Baker & Jones, 1993; Marsh & Yeung, 1998). The studies on gender differences in mathematics achievement were not touched upon broadly related to specific mathematical topics. But, it was clear that the studies examining the possible effects of gender factor on knowledge of history of mathematics were very limited. Thus, this study also aimed to contribute the literature via investigated this matter of concern.

## 2.6. The Relationship between Prospective Mathematics Teachers' Knowledge of History of Mathematics and Their Attitudes and Beliefs towards the Use of History of Mathematics in Mathematics Education

According to Maker (1982), there is a strong bidirectional relationship between affective and cognitive domains such that affective components in learning and teaching process may have an influence on cognitive components in the same process or vice versa. This relationship is not simple, various factors in the educational environment can affect it such as general beliefs towards teaching (Thompson, 1984). In order to explain this relationship, some arguments forwarded in the literature. As for Gilbert (1991), individuals must possess some knowledge of a specific topic before they express their attitudes and beliefs towards an issue related to that specific topic. The relationship between knowledge and attitudes and beliefs can also be explained by the idea that attitudes and beliefs are seen as a subjective form of knowledge (Lester, Garofalo, & Kroll, 1989). Furthermore, as a common point of knowledge and attitudes and beliefs, their possible impact upon the nature and quality of the education in mathematics classroom can be shown (Alexander & Dochy, 1995; Fennema & Franke, 1992; Thompson, 1992). They also differentiated from each other with fine lines. According to Thompson (1992), "disputability is associated with beliefs; truth and certainty is associated with knowledge" (p. 129).

In the context of this study, attitudes and beliefs towards the use of history of mathematics in mathematics education can be seen as affective components (McLeod, 1992; Thompson, 1992) and knowledge of history of mathematics can be regarded among cognitive components (Brown & Borko, 1992). Considering the mentioned arguments and studies, it might be possible to find a relationship between the prospective teachers' knowledge of history of mathematics and their attitudes and beliefs towards the history of mathematics usage in this study.

### 2.7. Summary of the Reviewed Literature

The review of the literature showed that the studies concerning the use of history of mathematics in mathematics education worked on the issue both in terms of theory and the various types of practices it employed (Tzanakis & Arcavi, 2000). There were certain arguments proposed many times in the literature in favor of the endeavor such as humanizing the subject (Fauvel & van Maanen, 2000; Freudenthal, 2000; Gulikers & Blom; Marshall, 2000), clarifying its close relation with society and culture (Baki & Güven, 2009; Heiede, 1996; Jankvist, 2010; Percival, 1999), helping organize the didactics of mathematics (Avital, 1995; Swetz, 2000; Tzanakis & Arcavi, 2000), motivating and taking attention to learn mathematics (Fasanelli et al., 2000; Oprukçu-Gönülateş, 2004; Philippou & Christou, 1998; Savizi, 2006), and helping understand the course (Freudenthal, 1981; Tzanakis & Arcavi, 2000). In addition to the further research studies, these common arguments about history in mathematics education also took the educational authorities' attention in most of the countries and also in Turkey. This interest reflected the policies about mathematics education like developing curricula (Fasanelli et al., 2000; Gulikers & Blom, 2002), designing textbooks (Durmuş, 2010a, 2010b, 2010c), and pre- or in-service teacher training programs (HEC, 2007; Heiede, 1996; MoNE, 2005).

Considering the increased attention to and the significance of incorporation of history of mathematics in mathematics education prospective elementary mathematics teachers should be examined in terms of their knowledge of history of mathematics in conjunction with their attitudes and beliefs towards the use of the history of mathematics in mathematics education. Future teachers with a considerable knowledge on the historical teaching method are needed because the method affects the nature and thus the quality of the mathematics instruction (Hiebert & Grouws, 2007), it saves the teachers from being dogmatic and just sticking to the textbooks (Heiede, 1996; Siu, 2000), and with these kind of characteristics, it may be the key of students' mastering school mathematics (Sowder, 2007). Examining the teacher candidates' attitudes and beliefs towards the historical method is needed because prospective teachers' beliefs have an impact upon their future choices in the mathematics classroom (Kagan, 1992). Finally, gender factor was included in the discussion of the attitudes and beliefs because of the possibility of any bias related to the gender on the historical method (Halpern, Wai, & Saw, 2005), and because gender may affect teacher beliefs towards their profession (Li, 1999).

Though the significance of educating prospective mathematics teachers on the incorporation of history of mathematics into mathematics education and the importance of investigating their attitudes and beliefs about this incorporation was stressed directly and/or indirectly in the literature with the arguments presented in this chapter, it can be said that the studies dealing with this endeavor is limited to a degree.

# CHAPTER 3

# METHODOLOGY

This chapter mainly contains the research design and procedures employed in this study under seven subtopics, which are the research design of the study, the population and sample, the instruments for data collection and measurement, data collection process, data analysis procedure, the internal and external validity of the study, and the assumptions and limitations of the study. Looking through the study's research design at the first step was believed to be helpful for seeing the whole picture of the methodology from a distance to have a main idea about it.

## 3.1. The Research Design of the Study

In this study, it was intended to explore Turkish prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education with respect to year enrolled in teacher education program and gender, and to reveal a possible correlation between the knowledge of history of mathematics and the attitudes and beliefs towards the usage of history of mathematics, and to have a general idea about the knowledge and the attitudes and beliefs. For achieving these purposes, cross-sectional survey research was used. According to Fraenkel and Wallen (2006), a cross-sectional survey research is gathering data via survey implementation from a sample representing the population of the study at a certain time point. The study also intended to clarify a possible relationship between the attitudes and beliefs and the knowledge about the history of mathematics regarding year enrolled in the teacher education program and gender. With respect to this aspect of the study, it could be regarded as correlational research since it is the study designed for clarifying the features of the relationship between four pairs of variables, which were year of enrollment and knowledge of history of mathematics, gender and knowledge of history of mathematics, year of enrollment and attitudes and beliefs towards the history of mathematics usage, and gender and attitudes and beliefs towards the history of mathematics usage (Gravetter & Wallnau, 2008). The design of the study could be seemed as a causal-comparative research due to the fact that the variables of gender and year enrolled in the undergraduate program were categorical (Fraenkel & Wallen, 2006). Herein, the underlying reason for preferring to name it as correlational research but not as causal-comparative research was Johnson's (2001) opinion that the distinction in the independent variable categorization (categorical versus quantitative) could not get more evidence about the causality in favor of causal comparative research. Considering the purposes together with the research design definitions presented, it can be stated that this study is a harmony of survey and correlational research.

### 3.2. The Population and Sample

The study's target population was entirely prospective elementary mathematics teachers in Turkey. The age range for this population was flexible, and typically it could be between 17 and 22. They graduated from several types of high school; most common ones would be Anatolian teacher education high school, Anatolian high school, and general high school. They were freshmen, sophomores, juniors, and seniors who were enrolled in the undergraduate program of elementary mathematics education in 47 universities (includes both state and private universities) located in each seven geographic region of the country. The accessible population of the study consisted of Turkish prospective elementary mathematics teachers who were studying in the universities which offered elementary mathematics education undergraduate program in all four years of enrollment. For the aim of generalizing the results of the study to all of the prospective elementary mathematics teachers in Turkey, the sample was determined as the prospective elementary mathematics teachers who were enrolled in the nine universities randomly selected in proportion to 20 percent among all universities in each geographical region of the country. This kind of sampling, which is called as cluster random sampling, was done for determining the representative universities of each region. Creswell (2003) defined cluster sampling as a multistage process comprising firstly determining groups and then reaching individuals in these groups for obtaining the data from them. In cluster random sampling, the groups, which the participants are designated, are selected randomly from all of them (Fraenkel & Wallen, 2006). In the study, the clusters corresponded to the universities with teacher education programs on elementary mathematics education in each region. Before setting the sample, all of the aforementioned universities were detached according to their geographic region for the purpose of counteracting any threat to the generalizability. All of the randomly selected universities were public universities. The sample of the study was formed of 1593 freshmen, sophomores, juniors, and seniors in the undergraduate program of elementary mathematics education in the academic year of 2010-2011. Prospective teachers in all levels were included in the study in order to examine the potential influence of year in teacher education program on prospective teachers’ attitudes and beliefs towards the use of history of mathematics in mathematics teaching and their knowledge about the history of mathematics. The selected universities in which the participants of the study enrolled in regions could be seen in Table 3.1 in the following page.

Table 3.1

*The Number of the Participants from Each Geographical Region of Turkey*

| Geographic Region | Selected Universities | Sample (n) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Freshmen | Sophomores | Juniors | Seniors | Total | Total (in percent) |
| Aegean | University A | 93 | 75 | 74 | 55 | 297 | 18.64 % |
| Black Sea | University B | 59 | 49 | 49 | 15 | 172 | 10.79 % |
| Central Anatolia | University C | 44 | 42 | 50 | 33 | 169 | 10.61 % |
| | University D | 32 | 37 | 34 | 38 | 141 | 8.85 % |
| Eastern Anatolia | University E | 95 | 91 | 79 | 86 | 351 | 22.03 % |
| Marmara | University F | 34 | 28 | 34 | 11 | 107 | 6.72 % |
| | University G | 37 | 49 | 36 | 13 | 135 | 8.48 % |
| Mediterranean | University H | 44 | 32 | 28 | 10 | 114 | 7.16 % |
| Southeastern Anatolia | University I | 40 | 28 | 26 | 13 | 107 | 6.72 % |
| Overall | | 478 | 431 | 410 | 274 | 1593 | 100 % |

The numerical information about the sample considering gender distribution was presented in Table 3.2 in the next page:

Table 3.2

*The Gender Distribution of the Prospective Teachers in the Sample*

| Geographical Region | Selected Universities | Female | Male | Total |
|---|---|---|---|---|
| Aegean | University A | 195 | 102 | 297 |
| Black Sea | University B | 121 | 51 | 172 |
| Central Anatolia | University C | 112 | 57 | 169 |
| | University D | 113 | 28 | 141 |
| Eastern Anatolia | University E | 218 | 133 | 351 |
| Marmara | University F | 73 | 34 | 107 |
| | University G | 89 | 46 | 135 |
| Mediterranean | University H | 83 | 31 | 114 |
| Southeastern Anatolia | University I | 60 | 47 | 107 |
| Overall | | 1064 | 529 | 1593 |

After being acquainted with the target and accessible population and the sample determined according to these, it may be beneficial to know the characteristics of the participants in this sample in more details.

Prospective teachers who are enrolled in elementary mathematics education undergraduate program take courses on mathematics, mathematics education, geometry, statistics, basic physics, English, history, educational sciences, computer and information technologies, research, and teaching practice (HEC, 2007). The courses on mathematics, science, foreign language and history are offered in the first and second years, the courses on educational sciences are distributed in all grades, the courses on mathematics education are studied in the third and fourth years, and the courses on teaching practice are placed in the fourth year. Precisely, regarding the courses related to the history of mathematics, the juniors have been taking History of Science, and the seniors had taken History of Science and they have been taking History of Mathematics as obligatory courses in eight of the nine universities. Hence, it was accepted that freshmen and sophomores did not take any courses related to the history of mathematics. In addition, no participant in the study took Philosophy of Mathematics course. These courses related to history of mathematics were suggested as general education courses, and there is not a special course on the use of history in mathematics education yet (HEC, 2007).

As mentioned before, this study was a cross-sectional survey research aiming to investigate Turkish prospective elementary mathematics teachers' knowledge on the past of mathematics and their attitudes and beliefs about the use of history of mathematics in mathematics education. For this purpose, the survey was conducted with the direct implementation of two different instruments called as Knowledge of History of Mathematics Test and Attitudes and Beliefs Questionnaire towards Using History of Mathematics in Mathematics Education. The instruments and their development process were explained in details in the next section.

### 3.3. The Data Collection Instruments

As it was mentioned in the significance of the study, developing valid and reliable, and also original instruments for the aims of ascertaining Turkish prospective elementary mathematics teachers' knowledge about the history of mathematics and determining their attitudes and beliefs towards the use of history of mathematics in mathematics teaching and took part among the purposes of the present study. The two measurement tools for the aims were developed as follows respectively: Knowledge of History of Mathematics (KHM) Test and Attitudes and Beliefs Questionnaire towards Using History of Mathematics in Mathematics Education (ABHME Questionnaire). The developments of these instruments were explained below.

#### 3.3.1. Knowledge of History of Mathematics (KHM) Test

Knowledge of History of Mathematics (KHM) Test was an instrument developed for the aim of investigating what Turkish prospective elementary mathematics teachers know related to the history of mathematics. There were 12 items in the KHM Test that were in the question forms of fill-in the blanks, short answer, true-false, and multiple choice (with four response options). The items were based on the use of the past of mathematics in classroom mathematics as 'illumination approaches', thus they were formed on some factual information about the history of mathematics (Jankvist, 2009). Most of the items were supported by visuals such as old portraits of known mathematicians, hieroglyphic drawings and pictures from ancient cultures, photographs of known instants from the history, and some modern drawings as well.

#### 3.3.1.1. The Pilot Study for KHM Test

The pilot study of the first version of KHM Test including 12 items was practiced with 237 prospective elementary mathematics teachers (53 males and 184 females). 45 first year, 52 second year, 97 third year and 44 fourth year student teachers comprised this participant group because of the reason that the actual study was intended to be conducted with prospective elementary mathematics teachers in all years of enrollment. This sample was selected conveniently from University J, which was a state university in Ankara.

It was also found to be necessary to display the courses which could affect the pilot study participants' knowledge about the history of mathematics. These courses were History of Science and History of Mathematics as obligatory courses (HEC, 2007). The course named History of Science contains the evolution of science under its branches of mathematics, physics, astronomy, chemistry, medicine and biology since the existence of the Near Eastern countries through Ionian-Hellene, Turk-Islamic and Western civilizations (the Renaissance era); on the other hand, History of Mathematics course comprised the specific examination of premier mathematicians, and their works (Gazi Faculty of Education, 2011). Taking these courses gave some idea about that the individuals of the pilot study sample were acquainted with history of mathematics especially in their further years in the elementary mathematics education undergraduate program.

#### 3.3.1.2. The Validity of KHM Test

The item pool of KHM Test initially included 20 questions. For determining the items for KHM Test, the history of mathematics related topics or concepts in Turkish national upper elementary (K6-8) mathematics curriculum (MoNE, 2009)and the formal textbooks written parallel to this curriculum (Durmuş, 2010a, 2010b, 2010c) were searched carefully. Moreover, mathematics teacher competencies suggested by MoNE (MoNE, 2011) also considered in the development process of KHM Test. The reason for limiting the resources with the curriculum and the textbooks was that prospective elementary mathematics teachers should meet the requirement of mastering the historical background information which elementary students learn. Therefore, the knowledge presented in the curriculum and the textbooks were considered as the base for the KHM test. The number of items in the pre-pilot version of the test was reduced to 12 after taking three mathematics education researchers' opinions on a table of specifications specially prepared for the test. After the pilot study, one of these 12 items was eliminated considering the views of an expert, who had a dissertation on the use of history in mathematics education. In this final version, two items had sub questions. When reducing the number of items, their reasonableness, difficulty, and conformity with the objectives given in the table of specifications were taken into account. The strategies described here were used as a way of getting evidence for the validity of the test. The test's table of specifications is given on Table 3.3 in the next page.

Table 3.3

*The Table of Specifications for KHM Test*

| | Learning Area | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Numbers | | | Geometry | | | | |
| Educational Objective | Addition and Subtraction | Rational Numbers | Ancient Numbers | Polygons | Measurement | Pythagorean Theorem | Mathematicians | Right triangle |
| Recognizes ancient cultures' mathematics | $Q_1$ | | $Q_2$, $Q_6$, $Q_8$ | | | | | |
| Knows the historical evolution of rational numbers | | $Q_5$ | | | | | | |
| Recognizes tangram | | | | $Q_7$ | | | | |
| Knows the historical evolution of π | | | | | $Q_3$ | | | |
| Masters Atatürk's contributions to mathematics | | | | | | $Q_4$ | | |
| Identifies premier mathematicians | | | | | | | $Q_9$, $Q_{11}$ | |
| Knows the history of trigonometry | | | | | | | | $Q_{10}$ |

In addition, Sample items from KHM Test are presented in Table 3.4 with the objective they measure:

Table 3.4

*Sample Items from KHM Test*

| Item Number | Objective | Sample Item |
|---|---|---|
| 1 | Recognizes some certain characteristics of different ancient cultures | **1.** – They have one of the known oldest number systems.<br>- They developed a number system up to millions before approximately 5000 years ago.<br>- Numerals in their mathematics are formed by juxtaposing some certain symbols.<br>- 7 different symbols constituting their numeration system was given below:<br><br><br>Which antique civilization has the above mentioned characteristics?<br>**A)** Mesopotamian Civilization<br>**B)** Roman Civilization<br>**C)** Egyptian Civilization<br>**D)** Babylon Civilization |
| 4 | Masters Atatürk's contributions to mathematics | **4.** <br>**i.** He took the first step for translating scientific terms into Turkish in Republic of Turkey.<br>**ii.** He defined and exemplified the geometrical terms like line, circle, parallel and triangle in his book named *Geometry*, which is for sale at present by The Council of Turkish Language.<br>**iii.** He became famous around the world with his studies on Algebra.<br>Which of the above arguments about Atatürk is/are correct?<br>**A)** Only ii **B)** i and ii **C)** i and iii **D)** All of them |
| 11.a | Identifies the premier mathematicians | **11.**<br>**a.** <br>He was a French mathematician lived in 17th century. He laid the foundations of modern probability theory, and studied on conics and projective geometry as well. He invented the first digital calculator for helping his father's tax collection. He spent too much time on a triangle formed of numbers, which was also sticked his name in our minds. This triangle was founded by Omar Khayyam, but it was thought that Chinamen had this knowledge before Khayyam.<br>Who is this mathematician? ........................................ |

Among the item examples from KHM test, the first one (Item 1) was about Egyptian mathematics. The basic characteristics of the ancient Egyptian mathematics were summarized in four statements, and a visual representation of the old Egyptian numeral system was presented as a tip. The second sample item (Item 4) asked the studies in the discipline of mathematics by Mustafa Kemal Atatürk, who is the founder of the Republic of Turkey. The last item (Item 11) was relevant to Blaise Pascal, a well-known French mathematician. Brief information about his life and the mathematical works which popularized him were given in connection with the names who studied the same mathematical topics before him. The latest version of KHM Test is given in Appendix A.

### 3.3.1.3. The Reliability of KHM Test

The responses to KHM test was coded dichotomously (0 corresponded to *not true* and 1 addressed *true*). The maximum score that one could get from the test was 13 (items with sub questions were two points items), and the minimum one was zero. Kuder-Richardson 20 coefficient, which addresses the reliability of the instrument when it generates dichotomous responses, was found as .42 for the pilot study of the test. The KR-20 value could be seen as low for interpreting that the instrument was reliable, but it was acceptable when the diagnostic characteristic of the test was considered. In diagnostic tests such as measuring knowledge of history of mathematics, even if there were adequate distractors and/or the knowledge examined was in appropriate level, the scores intensified near a certain point which reduced the standard deviation and such that lowered the reliability (Peşman & Eryılmaz, 2010).

The low reliability also could be attributed to relatively fewness number of the items (Pınarbaşı, Canpolat, Bayrakçeken, & Geban, 2006). The fewness of the number of the items was also the reason of not extricating any of the items from KHM Test before the beginning of the real study.

After the main study was finished, the reliability of the test was monitored again. The KR-20 coefficient was found as .56 this time based on the responses from 1593 prospective teachers. Furthermore, the reliability coefficient was also checked by calculating Cronbach Alpha reliability coefficient, which addressed .53 value. Though the test was implemented to a relatively high number of randomly selected participants, the reliability coefficient did not increase to the desired level. Thus, this calculation was believed to strengthen the claim that the reasons laid beneath the low reliability value were sample characteristics as mentioned and the number of questions in the scale.

### 3.3.2. Attitudes and Beliefs towards the Use of History of Mathematics in Mathematics Education (ABHME) Questionnaire

The final version of the ABHME Questionnaire included two subsections as demographic information and the actual questionnaire items for measuring the history of mathematics related attitudes and beliefs. The first subsection required the information from participants on their gender, year of undergraduate program, graduated high school type, name of university, and also whether they had been mentioned about history of mathematics or not with how often they followed the publications about history of mathematics. 35 Likert type items for investigating participants' attitudes and beliefs towards the use of history of mathematics in the teaching and learning of mathematics formed the second subsection.

The instrument's development process was started with deeply reviewing the existing literature on the field of using history in mathematics education, and the analysis of Turkish national upper elementary curriculum (MoNE, 2009). After the literature review, an item pool with 220 items was generated considering the arguments related to the mentioned usage of history of mathematics and adopting some items from the existing instruments by taking the necessary ethical permissions (e.g., Clark, 2006; Fraser & Koop, 1978; Oprukçu-Gönülateş, 2004; and Percival, 1999, 2004). The number of items in the item pool was reduced to 40 after gaining mathematics education researchers' opinions. The items were grouped according to the usefulness of the benefiting from history of mathematics in the teaching and learning of mathematics, the potential of the history integration regarding help appreciate mathematics as a scientific discipline and apprehend the concepts of mathematics, and self-efficacy of prospective teachers about the use of the history of mathematics. Furthermore, the nominee items that were parallel in meaning unified, the superficial existing items coming from the literature were eliminated, and the new written items which dislocated the goal of the study were removed during this process. Before the pilot study, the response scale for the 40 items was determined in the following order: 'strongly disagree', 'disagree', 'undecided', 'agree', and 'strongly agree'. 13 of the items were negative and the rest were positive items.

The distinction between the concepts of belief and attitude was taken into consideration as it was addressed in the first and second chapters, but these two kinds of items were placed intricately into the questionnaire due to the opinion that these two concepts were so close and able to congregate under one framework which was affect in mathematics education (Leder & Forgasz, 2002). It can be said that the items with more rigid statements corresponded to the items about the beliefs and those contained smoother expressions corresponded to the attitudinal ones. On Table 3.5, one sample statement from the final version of ABHME Questionnaire for each of these affective constructs was presented.

Table 3.5

*Sample Items from ABHME Questionnaire for Attitudes and Beliefs*

| Item Number | Affective Construct | Item |
|---|---|---|
| 32 | Attitude | I do not plan to use the learning activities based on history of mathematics. |
| 1 | Belief | It is difficult to integrate history in mathematics education. |

The ABHME Questionnaire was ready for its pilot study after it was given its first structure with the 40 items. The items were ordered randomly in the first version of the scale.

#### 3.3.2.1. The Pilot Study for ABHME Questionnaire

ABHME Questionnaire was piloted with the same participants of KHM Test, who were 237 prospective elementary mathematics teachers from the same university (University J). Before analyzing the obtained data from this pilot study, hot deck imputation technique was employed for coping with the missing values and the negative items were reversed (Little & Rubin, 1987). PASW Statistics 18 software program then was utilized in the validity and reliability analysis of the pilot study which were addressed in the following minor headings.

#### 3.3.2.2. The Validity of ABHME Questionnaire

With respect to Fraenkel and Wallen (2006), the validity characteristic of an instrument can be interpreted as whether it was able to measure or not the things that the researcher aimed to measure. The validity of the ABHME Questionnaire, referred to whether it could appropriately measure the attitudes and beliefs of prospective elementary mathematics teachers related to the aforementioned history-usage subgroups and under what components it would able to measure these subtopics. The validity of the questionnaire was tested by gathering content-related and construct-related kinds of evidence.

The content-related evidence of validity was provided via taking the opinions of three elementary mathematics education researchers, and one elementary science education researcher. These researchers have conducted studies related to the affective issues of education. Before conducting the pilot study, they helped for the reduction of the number of the items. They checked the instrument's format, and also the adequateness of the item quantity in comparison with the extensiveness of the related subtopics (Fraenkel & Wallen, 2006).

The construct-related validity evidence was ensured through running exploratory factor analysis which would provide information about under which components the instrument would work. George and Mallery (2001) claimed that factor analysis served the purpose of sorting the items which were interrelated in a test into sub dimensions (factors). Before the factor analysis was conducted, its assumptions that Pallant (2007) offered as sample size, factorability of the correlation matrix, outliers among cases, and linearity were initially controlled. According to Tabachnick and Fidell (2007), the quantity of the sample should be minimally five times of the items of an instrument which was prepared for its pilot study. The 237 participants of the pilot study was greater than 200, which is the product of five times 40 items, thus it was seen that the sample size was suitable. Kaiser-Meyer-Olkin (KMO) sampling adequacy measure, Bartlett's test of Sphericity and the correlation matrix were consulted with the purpose of checking the factorability of the correlation matrix. They KMO measure was found to be .871 with a statistically significant Bartlett's test of Sphericity ($\chi^2$=3447.582 and p=.000), and there were correlation coefficients of .3 or more among many pairs of items in the correlation matrix. These evidences were sufficient for reaching the idea that continuing the interpretation of the factor analysis was suitable (Tabachnick & Fidell, 2007). Since the sample size was adequate, there was no need for checking the assumption of linearity (Pallant, 2007). Finally, no outliers could be found in the obtained pilot data.

For determining the components of the instrument, principal components factor extraction technique with varimax rotation was selected. The number of the components was restricted to three due to Pallant's (2007) idea that a specific factor number could be assigned if it was thought to identify the interrelationships among the factors optimum.

The initial eigenvalues appeared in the factor analysis about the three factors were given in Table 3.6, which also shows that the cumulative percentage of the variance was generated as 38.13 which was close to the value that Kline (1994) offered as 40 percent to be acceptable.

Table 3.6

*Initial Eigenvalues of the Factors*

| Number of the Factor | Initial Eigenvalues | | |
|---|---|---|---|
| | Total | % of Variance | Cumulative % |
| 1 | 9.89 | 24.73 | 24.73 |
| 2 | 2.89 | 7.23 | 31.97 |
| 3 | 2.47 | 6.17 | 38.13 |

The items were appointed into the components considering their factor loadings in the rotated component matrix, and Pallant's (2007) idea that the number of items in a component could be at least three. The minimum factor loading of an item was determined as .3 for appraising that it belonged to any one of the factors.

The item numbered as 38 was extricated from the instrument since it could not ensure this determination. Additionally, Büyüköztürk (2010) stated that the maximum factor loading of an item to one factor ought to be at least .1 more in comparison with its loadings to the rest of the factors which was the reason of removing the items 1, 2, 29 and 37. The final version of ABHME Questionnaire is given in Appendix B. The rotated component matrix of the factor analysis is presented in Appendix C, and the removed items are also given in Table 3.7.

Table 3.7

*The Removed Items from ABHME Questionnaire*

| Removed Item |
|---|
| * Mathematics is a routine course without its history. |
| * Courses related to history of mathematics should be given compulsorily in undergraduate programs on mathematics teaching. |
| * Mathematics prospective teachers' learning of history of mathematics is not important in terms of their professional improvement. |
| * Comprehensive research projects about history of mathematics should be given to elementary (K6-8) students. |
| * I am knowledgeable about the mathematics used by antique civilizations (such as Egyptians) as much as that I can integrate them into mathematics education. |

After the examination of the possible constructs according to the grouping of the items in the rotated component matrix and the existing research on scale development in social sciences (e.g., Cantürk-Günhan & Başer, 2007), three factors were named reasonably as Positive Attitudes and Beliefs towards the Use of History of Mathematics in Mathematics Education (Positive ABHME), Negative Attitudes and Beliefs towards the Use of History of Mathematics in Mathematics Education (Negative ABHME), and Self-Efficacy Beliefs towards the Use of History of Mathematics in Mathematics Education (SBHME). Here are the items of Positive ABHME factor in Table 3.8:

Table 3.8

*Items under the Factor Named 'Positive ABHME'*

| Item Number | Item |
|---|---|
| 2 | Having knowledge about history of mathematics gives an idea about that why humans was felt the need for mathematics. |
| 3 | The utilization of history of mathematics in mathematics instruction makes positive contribution to the learning of mathematics by providing a different standpoint and presentation. |
| 5 | Noticing that the premier mathematicians also made mistakes when dealing with mathematics enhances students' motivation for the learning of mathematics. |
| 6 | Learning history of mathematics enriches prospective teachers' professional repertoire. |
| 7 | Prospective teachers must be given courses about how to use history of mathematics in mathematics education. |
| 8 | History of mathematics enables us to link the mathematical concepts and see the close relationships between them. |
| 9 | Mathematics' history help students in depth comprehend mathematics via introducing alternative approaches and various examples. |
| 10 | History of mathematics makes students to notice that mathematics is a universal product. |

(continued)

Table 3.8

*Items under the Factor Named 'Positive ABHME'*

| Item Number | Item |
|---|---|
| 13 | Mathematics education integrated with history of mathematics monitors a more realistic and comprehensive picture about what mathematics is. |
| 14 | Real life problems chosen from history of mathematics should be used in mathematics education. |
| 15 | History of mathematics is a practical tool for the teaching of mathematics. |
| 16 | History of mathematics should be integrated into mathematics education. |
| 18 | Written and visual history-based didactical materials can be developed by using history of mathematics (e.g., worksheets, plays, puzzles, documentaries and cartoons). |
| 19 | History of mathematics helps grasp the role and importance of mathematics in society. |
| 22 | History of mathematics enables students to rediscover mathematics by using their own talent and experiences. |
| 24 | The examination of the old sources of mathematics allows teachers and students to notices the advantages of modern mathematics. |
| 26 | Mathematics' history assists the change of classroom environment from a place in which knowledge is transferred to a platform in which research is made. |
| 27 | History-based learning activities should be included in the elementary (K6-8) mathematics curriculum. |
| 28 | Prospective mathematics teachers must have knowledge and ideas about the historical evolutions of mathematical concepts. |

(continued)

Table 3.8

*Items under the Factor Named 'Positive ABHME'*

| Item Number | Item |
|---|---|
| 30 | History of mathematics provides us to notice the contributions of mathematics to the other scientific disciplines (e.g., physics) and its connected relationship with them. |
| 31 | The comparisons of the handling of mathematical concepts in old and modern mathematics help students understand mathematics. |
| 34 | Knowing the historical development of the mathematical topic being studied enables students to learn that topic better. |

The items of the factor named Negative ABHME were presented in Table 3.9 in the next page.

Table 3.9

*Items under the Factor Named 'Negative ABHME'*

| Item Number | Item |
|---|---|
| 1 | It is difficult to integrate history in mathematics education. |
| 4 | Using the history in mathematics education causes students to lose their enthusiasm for mathematics. |
| 20 | Giving place to mathematics' history by teacher in mathematics lessons increase students' mathematics anxiety. |
| 21 | Including history in mathematics education hinders mathematics teaching. |
| 23 | The integration of history of mathematics in elementary (K6-8) mathematics curriculum increases teachers' and students' mathematics course load. |
| 25 | Teaching activities developed based on history of mathematics will not gain students' interests in classroom setting. |
| 32 | I do not plan to use the learning activities based on history of mathematics. |
| 33 | Using history of mathematics originated didactical materials in mathematics lessons causes waste of time. |
| 35 | It is not important to use history of mathematics in mathematics lessons. |

Finally, Table 3.10 given below included the items of the factor named SBHME:

Table 3.10

*Items under the Factor Named 'SBHME'*

| Item Number | Item |
|---|---|
| 11 | I do not have an idea about how to use historical materials. |
| 12 | I do not know how to integrate history in mathematics teaching process. |
| 17 | I do not have enough information about the historical evolutions of the concepts which I will teach in the future. |
| 29 | I do not know the place of the history of mathematics in elementary (K6-8) curriculum. |

When the factor analysis was conducted once more for the finalized version of the ABHME Questionnaire (with 35 items), it was noticed that the calculated values slightly changed. Without the five extricated items, 39.71 percent of the variance was described by the factors which were better for the appropriateness of the factor analysis (Kline, 1994).

#### 3.3.2.3. The Reliability of ABHME Questionnaire

In the context of this study, the concept of reliability could be defined as the internal consistency among the items of an instrument (George & Mallery, 2001). The reliability of the questionnaire was checked via calculating the Cronbach Alpha coefficient of the responses in the pilot implementation. The coefficient was found as

.91 pointing a high internal consistency among the items. In respect of George and Mallery's (2001) viewpoint, that means the questionnaire had a very good reliability.

After reducing the number of the items to 35 in the finalized version of the scale, Cronbach Alpha reliability coefficient was found for as .90. It can be stated that the reliability of the whole scale was quite good for its final version. Furthermore, the reliability coefficient for each appeared factor of the instrument was separately calculated. The Cronbach Alpha values for the factors of the instrument are given in Table 3.11.

Table 3.11

*Reliability Coefficients for Each Factor of ABHME Questionnaire in the Pilot Study*

| Factor Name | Number of Items in the Factor | Cronbach Alpha Reliability Coefficient |
|---|---|---|
| Positive ABHME | 22 | .91 |
| Negative ABHME | 9 | .85 |
| SBHME | 4 | .73 |

In respect of Pallant's (2007) view, the coefficient as .91 found for the factor named Positive ABHME addressed a very good reliability, the coefficient as .85 for the second factor referred a preferably reliable component and the last coefficient .73 calculated for SBHME factor pointed an acceptable reliability.

After conducting the main study, the reliability of ABHME Questionnaire was computed one more time. As an indicator of the reliability Cronbach Alpha coefficient was detected as .93. This value, which was calculated from the data collected with a kind of random sampling from a heterogeneous participant distribution, was another evidence for supporting and strengthening the idea that the scale was reliable to be utilized. Additionally, new reliability coefficients for each component of the scale were also found with the main data of the study. The values are presented in Table 3.12 below:

Table 3.12

*Reliability Coefficients of ABHME Questionnaire's Factors Founded with the Actual Study*

| Factor Name | Number of Items in the Factor | Cronbach Alpha Reliability Coefficient |
|---|---|---|
| Positive ABHME | 22 | .93 |
| Negative ABHME | 9 | .87 |
| SBHME | 4 | .74 |

As it was shown in the previous table, Cronbach Alpha coefficients met for the actual study data exhibited parallel results with those calculated according to the pilot study data.

### 3.4. The Data Collection Process

The data collection started after the necessary permissions were taken from the Research Center for Applied Ethics ethical committee at Middle East Technical

University after the pilot studies of the two instruments completed. The sample of the study would be chosen by clustered random method of sampling. The clusters used in the sampling, which were universities training prospective elementary mathematics teachers in all years of enrollment, were chosen randomly for each geographical region by running *randbetween* function of Microsoft Office Excel software program. Herein, it should be specified that the proportion for the random selection in each region was 20 percent of the total number of the universities located in that region. After the universities were selected, necessary correspondences with the nine universities of the sample were actualized via the formal agencies in Middle East Technical University, and the permissions for the implementation of the two instruments were gathered. The data collection process was started in the last week of November 2010 and finished in the first week of January 2011 and it took about six weeks.

The scales were implemented in the classroom settings to the participants through the same process in the pilot and the actual study. Total time required for each of the implementations of the two scales was about 30 minutes. Both scales were developed in Turkish, and they were administered together once at a time in the order of ABHME Questionnaire and KHM Test. Before one administration, the prospective teachers were informed about the reason for conducting the study, its research value, and how to respond the items of each instrument. Additionally, it was declared that they were not required to attend the administrations and that they could leave the study at any time they want. They were not required to provide any information regarding their identity in order to make them feel comfortable in while responding the scale items.

### 3.5. Data Analysis Procedure

The data gathered from ABHME Questionnaire and KHM Test was quantitative, thus PASW Statistics 18 program was used for both descriptive and inferential analysis. The demographic information of the participants were gathered via the first part of the ABHME Questionnaire and presented through the use of frequency and percentage. The responses for the each item of the ABHME Questionnaire were revealed with these techniques which were scored on a scale where 1 corresponded to the response option of ‘strongly disagree’ and 5 corresponded to the response option named ‘strongly agree’. Through this scoring, an overall score for each participant was calculated by taking the sum of the scores for each item. The maximum and minimum scores that a participant could have were 175 (the richest positive attitudes and beliefs in question) and 35 (the poorest positive attitudes and beliefs in question) in turn. Before the calculation of the overall scores that the participants gathered from the questionnaire, the negative items were reversed into their positive expressions.

The first and second research questions were set in order to examine the prospective teachers’ knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education. Minimum-maximum values, mean, and standard deviation were the descriptive statistical techniques which were used to make this examination. The third research question was written for the investigating of the possible year of enrollment and gender differences in Turkish prospective elementary mathematics teachers' knowledge about the history of mathematics. This question was answered through the two-way between-groups ANOVA. The same statistical analysis was also used for the fourth research question, which was asked for displaying the potential effects of year of enrollment and gender on the participants' attitudes and beliefs towards the incorporation of history of mathematics in mathematics instruction. In addition, Pearson Correlation was used to the exploration of the fifth research question, which aimed to the invention of a possible relationship among Turkish prospective elementary mathematics teachers' attitudes and beliefs towards the use of history of mathematics in mathematics education and their knowledge of history of mathematics.

### 3.6. The Internal and External Validity

The threats to the internal and external validity were discussed respectively considering the design of the study under the two following subheadings.

#### 3.6.1. The Internal Validity of the Study

Fraenkel and Wallen (2006) addressed the internal validity as "…observed differences on the dependent variable are directly related to the independent variable and not due to some other unintended variable" (p. 169). Since it was taken into consideration that this study had a mixed design of correlational research with survey research and the process of the data collection, the possible threats to its internal validity were stated as subject characteristics, loss of subjects (or mortality), location, instrumentation and history (Fraenkel and Wallen, 2006). These threats were addressed in the following paragraphs in details.

Subject characteristics threat is the potential influence of some certain characteristics of the participants in a study on any variable which is aimed to be measured in that study (Fraenkel & Wallen, 2006). In this study, the participants' extraordinary interest in the history of mathematics and the usage of it in the teaching of mathematics could be seen as threats for the occurred results of the study. This issue was accepted as a limitation, and the results of the study were discussed considering this limitation. Second, since the sample was randomly chosen from different geographic regions of Turkey, potential threats stemming from the cultural and ethnical origin of the participants were attempted to be inhibited. Last, since the Elementary Mathematics Education programs are standardized to a great degree by HEC (2007) throughout the country, it was presumed that the education that was offered in these undergraduate programs was considerably similar in terms of courses and experiences.

Mortality threat could be defined in Fraenkel and Wallen's (2006) viewpoint as the danger of participants' withdrawal from the study due to personal reasons such as being tired of participating in the study. In some of the implementations in the course of the study's data collection, some participants gave up answering the scales which could be considered as a threat to the internal validity of the study. Yet, since a total of three participants from different geographical regions did not fully complete the instruments, this threat was eliminated considering the total number of participants who completed the scales. Incomplete scales were removed from the data of the study.

The location threat refers to the possible undesirable effect of the place of implementation on the results of the study (Fraenkel & Wallen, 2006). All of the implementations were conducted in regular classroom environments of the teacher education programs. Thus, it was thought that location did not constitute a problem for this study.

Other threats to internal validity of the study were the threats originated from the instrument decay, data collector characteristics and data collector bias that Fraenkel and Wallen (2006) addressed as instrumentation threat. First of all, the questionnaire and test implemented in the study were designed in order not to exhaust the participants within 25 minutes, since there were not any items which would need considerable efforts and time such as open-ended items. The characteristics of the data collector, was assumed to have a very limited effect on the results of the study because the researcher collected the data in eight of the universities and he samely approached to all participants by explaining the study and kindly asking for their contribution. He did not interact with the participants about the responses of the KHM Test and ABHME Questionnaire. In the one university in which the researcher did not collect the data, the data collectors who were graduate assistants were informed about the data collection procedure in detail. The history threat arises for many unexpected events during the collection of the data (Fraenkel & Wallen, 2006). In one of the administrations, the lecturer of the course made some criticisms about the study loudly in the classroom. This case naturally disrupted the prospective teachers' attention in that implementation, but it was carefully handled by the researcher by reminding the aims of the study with reference to its educational and scientific importance.

### 3.6.2. The External Validity of the Study

Fraenkel and Wallen (2006) defined a research study's external validity as "The extent to which the results of a study can be generalized determines the external validity of the study" (p. 104), and also stated the cases that should be addressed in this attempt as: "Both the nature of the sample and the environmental conditions –the setting- within which a study takes place must be considered in thinking about generalizability" (p. 104). As mentioned at the beginning this chapter, the target population of the study was all prospective elementary mathematics teachers studying at the universities located in Turkey. Among all of Turkish prospective elementary mathematics teachers, those who enrolled in the universities having elementary mathematics education undergraduate program with all years of enrollment constituted the accessible population. In the sampling process, first Turkey was separated into its official geographical regions and the instruments were implemented to as many prospective teachers as in those universities whose selection process was mentioned before. This method of sampling was called as clustered random sampling, where the universities corresponded to the clusters. The reason for choosing this sampling method was that it was not possible to select the participants of the study randomly in this respectively limited research process, and reaching all of them would be very difficult. In Fraenkel and Wallen's (2006) view, this kind of sampling was appropriate if great number of clusters could be determined, and it also produces results which represents the whole population. Thus, the results of this study can be generalized to the target population contentedly.

Fraenkel and Wallen's (2006) describe ecological generalizability as "…the degree to which the results of a study can be extended to other settings and conditions" (p. 106). The participants of this study were from all year levels of the elementary mathematics education program. They were from universities which were located in different geographical regions of Turkey. The undergraduate program on elementary mathematics education optionally offered them to select the courses relevant to history of mathematics in the third or fourth academic years. Considering these, it can be claimed that the results of this study is highly generalizable.

## 3.7. The Assumptions and Limitations of the Study

Related to the implementation process of the instrument, it should be initially stated that the participants of the study were assumed to give their responses carefully to both instruments through their own thoughts. The time in which the implementations were carried out created a limitation which could not be obstructed due to the predetermined implementation schedule. It was considered that two kind of time effects existed: the schedule time of the academic term and the time of the day when the implementations were done. About the first one, some of the data collections were conducted close to the end of the fall semester of the 2010-2011 academic term. This reduced the number of the participants in comparison with the number of the participants in the earlier implementations conducted in the beginning of December 2010. The second one was sourced from the time of the day or class implementations were conducted. Conducting the data collection during the evening classes and/or at the end of class hours might have reduced the participants' care on the instruments. Another limitation regarding the data collection process was that the data were gathered according to the concerned authorities' permission in each of the universities. This naturally might affect the balance of the data gathered from each geographical region of Turkey. Put it differently, limited data than the expected were gathered in some universities, and excessive data were collected in some of the rest. But when the results of the research examined, it was noticed that this situation did not negatively influence the numbers of the two demographic independent variables, which were year in teacher education program and gender. Lastly, the quantitative instruments used in the study took the participants' history of mathematics related attitudes and beliefs and their knowledge of history of mathematics in a certain form.

The study's methodological nature might have also limited the results and the interpretations. Since the study was a kind of survey research, it was performed with quantitative research techniques. This quantitative kind of research brought along some constraints with itself. For instance, the participants' expressions about their attitudes and beliefs towards the history usage were restricted with the items in

ABHME Questionnaire. Their relevant attitudes and beliefs behind the scope of the questionnaire could not be assessed. They were not permitted to deeply mention about what they believe regarding the use of history of mathematics in mathematics education. The national upper elementary mathematics curriculum (MoNE, 2009) and the formal Ministry of National Education textbooks (Durmuş, 2010a, 2010b, 2010c) were thought to be the common point about what the prospective teachers should master on the history of mathematics, but they limited the source for designing the KHM Test.

# CHAPTER 4

# RESULTS

This study intended to explore on the potential roles of year of enrollment and gender on Turkish prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics teaching and learning. Furthermore, a possible relationship between the constructs of knowledge of history of mathematics and attitudes and beliefs towards the history integration were investigated. Data of the study were collected through implementing KHM Test and ABHME Questionnaire to 1593 prospective elementary mathematics teachers. The data analysis was started with the examination of the demographic information regarding the sample. The descriptive statistics about the participants' knowledge of history of mathematics and their attitudes and beliefs related to the use of history of mathematics in mathematics education were presented. Related to the inferential statistics, two-way ANOVA was utilized in order to clarify a possible difference among both the knowledge of history of mathematics in respect of year enrolled in teacher education program and gender, and the attitudes and beliefs towards the use of history of mathematics in mathematics education in respect of year enrolled in teacher education program and gender. Pearson product-moment correlation analysis was done for examining the relationship between participants’ knowledge about the history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education.

## 4.1. Demographic Information

The variables that identified the demographic information from the sample were gender, year enrolled in teacher education program, high school graduated, and the geographical region.

The information about dispersion of the participants regarding gender and year enrolled in teacher education program are presented in Table 4.1.

Table 4.1

*Demographics Regarding Gender and Year Enrolled in Teacher Education Program*

| Year Enrolled in Teacher Education Program | Female | | Male | | Total | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| 1st | 328 | 20.6 | 149 | 9.4 | 477 | 30 |
| 2nd | 300 | 18.8 | 128 | 8 | 428 | 26.8 |
| 3rd | 260 | 16.3 | 150 | 9.4 | 410 | 25.7 |
| 4th | 176 | 11.1 | 102 | 6.4 | 278 | 17.5 |
| Total | 1064 | 66.8 | 529 | 33.2 | 1593 | 100 |

Table 4.1 presented that most of the prospective teachers in the sample were in their first year in the teacher education program. In addition, the seniors were presented the least. The dispersion related to gender indicated that the number of the females were nearly two times that of males. In every year of the program, the numerical superiority of female participants to the males drew the attention as well.

The results showed that 767 of the participants (%48.1) were from Anatolian Teacher Education High School, 458 of them (%28.8) from Anatolian High School, 207 of them (%13) were from general high school, 98 of them (%7.2) were from foreign language weighted high school, and 46 of them (%2.9) were from other kinds of high schools. 17 participants did not respond to the item indicating graduated high school information. Considering the distribution of the participants according to the graduated high schools, the number of the prospective teachers coming from Anatolian teacher education high school and the rest were nearly balanced (%48.1 to %51.9 in turn).The distribution of the sample in terms of geographical regions by percentage is given in Figure 4.1 in the next page:

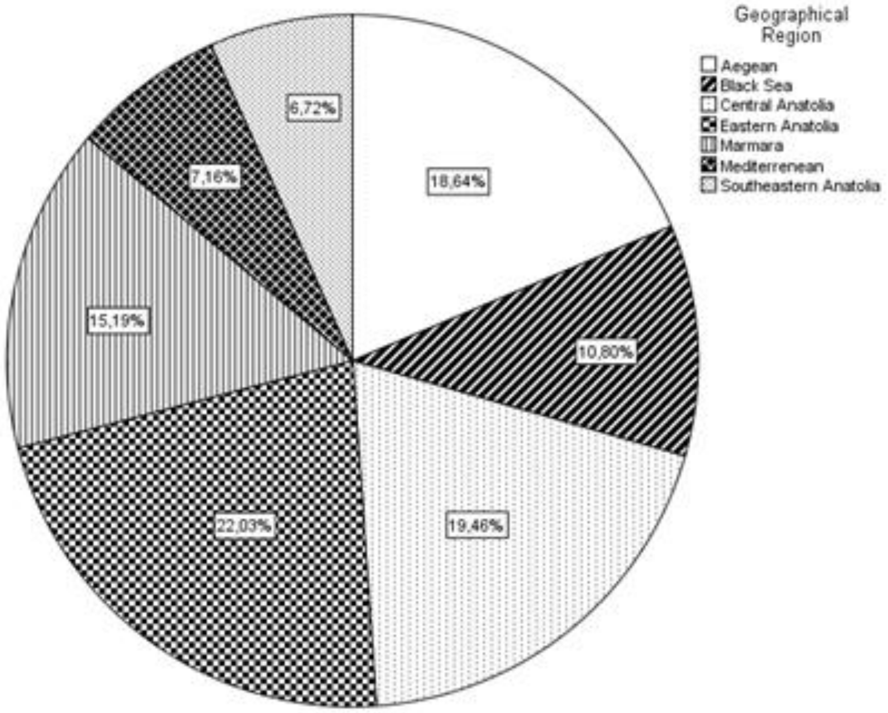


*Figure 4.1* Distribution of the sample in respect of geographical region by percentages.

As the figure above represented, the most part of the data were gathered from Central Anatolia and Eastern Anatolia geographical region. The least contribution was made by Mediterranean and Southeastern Anatolia regions.

The participants also asked for whether history of mathematics was mentioned or not during their school life and how often they would follow the publications (such as magazines, books, and documentaries) in order to have information about being familiar with history of mathematics. Among the participants, 953 (%59.8) of them stated that they did not take any courses related to the history of mathematics, and 635 (%39.9) of them said that they have taken.

Related to their personal interests in the history of mathematics, 498 (%31.3) of them expressed that they never followed the publications on the history of mathematics, 1039 (%65.2) said ‘sometimes’, 49 (%3.1) chose ‘often’, and only two (%0.1) of them selected the response option of ‘always’.

## 4.2. Descriptive Statistics

Turkish elementary prospective teachers’ knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education were examined via minimum-maximum values, means, standard deviations, and skewness-kurtosis values. Through this examination, two important demographics of the study, which were gender and year enrolled in teaching program, were considered as well.

### 4.2.1. Turkish Prospective Elementary Mathematics Teachers’ KHM and Their ABHME

The first two research questions were respectively as follows:

To what extent do Turkish prospective elementary mathematics teachers have the knowledge of history of mathematics?

What is the level of attitudes and beliefs of Turkish prospective elementary mathematics teachers towards the use of history of mathematics in mathematics education?

The prospective elementary mathematics teachers' knowledge of history of mathematics was investigated by the results obtained from KHM Test with 11 items. The responses by the participants to this test were dichotomously coded as '0' and '1' corresponding to 'not true' and 'true' in order. A mean score for the test was calculated for each participant by taking average of the values of his/her responses to all of the items. Higher mean scores meant higher knowledge of history of mathematics. The maximum mean score that the participants could get was '1'. Table 4.2 presents the descriptive results.

Table 4.2

*Descriptive Results for KHM Scores*

| | N | Min. | Max. | Mean | SD | Skewness | | Kurtosis | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Stat. | SE | Stat. | SE |
| KHM | 1593 | .00 | .92 | .44 | .16 | .17 | .06 | -.25 | .12 |

As Table 4.2 indicated, the participants' knowledge of history of mathematics ranged from .00 to .92. The mean score for this knowledge was .44 out of 1 with a standard deviation value of .16. Considering this value, it might be inferred that the prospective teachers' knowledge of history of mathematics was lower than moderate. The values of skewness and kurtosis indicated that the distribution of the prospective teachers' mean knowledge scores was normal.

Participants' attitudes and beliefs towards the use of history of mathematics in mathematics education were examined through ABHME Questionnaire whose finalized version had 35 items. The responses of the participants to this scale were coded as '1', '2', '3', '4', and '5' corresponding to 'strongly disagree', 'disagree', 'undecided', 'agree', and 'strongly agree' respectively. A mean score for the questionnaire was found for each participant by taking average of the values of his/her responses to the 35 items. Higher mean scores addressed higher attitudes and beliefs towards the use of history of mathematics in mathematics education. The maximum mean score that the participants could get was '5', and the minimum mean score was '1'. On Table 4.3, the relevant descriptive results are exhibited.

Table 4.3

*Descriptive Results for ABHME Scores*

| | N | Min. | Max. | Mean | SD | Skewness | | Kurtosis | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Stat. | SE | Stat. | SE |
| ABHME | 1593 | 1.20 | 4.89 | 3.67 | .49 | -1.04 | .06 | 2.54 | .12 |

Considering Table 4.3, it can be stated that the values corresponding to the participants' attitudes and beliefs towards the use of history of mathematics in mathematics education were between 1.20 and 4.89. The mean score for the attitudes and beliefs was 3.67 out of 5 with a standard deviation value of .49. This meant that prospective teachers had moderately high attitudes and beliefs towards the integration of history of mathematics into mathematics education. The skewness value was -1.04 which a value between -2 and +2 was. It meant that this skewness value did not violate the normality assumption (Kunnan, 1998). But that the kurtosis statistic was higher than two, which implied an underestimation of variance related to the distribution of the mean scores on ABHME Questionnaire, but this underestimation was not in question here since the sample size was greater than 30 (Pallant, 2007). Thus, the high kurtosis value did not constitute a problem for the normality of the distribution.

To form an idea about the roles of gender and year in the program in the prospective teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education, the related mean and standard deviation scores were detailed given in Table 4.4 in the following page.

Table 4.4

*Descriptive Statistics Regarding KHM and ABHME Scores associated with Year Enrolled in Teacher Education Program and Gender*

| Gender | Year Enrolled in Teacher Education Program | KHM | | ABHME | | |
|---|---|---|---|---|---|---|
| | | M | SD | M | SD | N |
| Female | 1st | .34 | .12 | 3.61 | .52 | 328 |
| | 2nd | .38 | .15 | 3.70 | .36 | 300 |
| | 3rd | .50 | .16 | 3.77 | .46 | 260 |
| | 4th | .56 | .15 | 3.80 | .46 | 176 |
| | Overall | .43 | .17 | 3.71 | .46 | 1064 |
| Male | 1st | .39 | .14 | 3.51 | .54 | 149 |
| | 2nd | .42 | .14 | 3.56 | .49 | 128 |
| | 3rd | .49 | .16 | 3.69 | .53 | 150 |
| | 4th | .56 | .14 | 3.69 | .58 | 102 |
| | Overall | .46 | .16 | 3.61 | .54 | 529 |
| Total | 1st | .36 | .13 | 3.58 | .53 | 477 |
| | 2nd | .39 | .15 | 3.66 | .41 | 428 |
| | 3rd | .50 | .16 | 3.74 | .49 | 410 |
| | 4th | .56 | .15 | 3.76 | .51 | 278 |
| | Overall | .44 | .16 | 3.67 | .49 | 1593 |

Considering the variable of gender, the knowledge of history of mathematics that females (*M*=.43, *SD*=.17) and males (*M*=.46, *SD*=.16) had were very close to each other. Related to the participants' year in the undergraduate teaching program, an increase (for freshmen, *M*=.36, *SD*=.13; for sophomores, *M*=.39, *SD*=.15; for juniors, *M*=.50, *SD*=.16; and for seniors, *M*=.56, *SD*=.15) in the year was accompanied with increase in the knowledge of history of mathematics. This accompanying increase was also eligible for both females (for freshmen, *M*=.34, *SD*=.12; for sophomores, *M*=.38, *SD*=.15; for juniors, *M*=.50, *SD*=.16; and for seniors, *M*=.56, *SD*=.15) and for males (for freshmen, *M*=.39, *SD*=.14; for sophomores, *M*=.42, *SD*=.14; for juniors, *M*=.49, *SD*=.16; and for seniors, *M*=.56, *SD*=.14).

As Table 4.4 clarified, the results demonstrated that the teacher candidates' attitudes and beliefs towards the use of history of mathematics in mathematics education were relatively positive (*M*=3.67, *SD*=.49). Taking into account the gender variable, the attitudes and beliefs towards the use of history of mathematics in mathematics education that females (*M*=3.71, *SD*=.46) had were relatively more positive than males' attitudes and beliefs (*M*=3.61, *SD*=.54). As the participants' year in the program increased, their attitudes and beliefs towards the use of history of mathematics in mathematics education increased as it was also noticed for their knowledge of history of mathematics (for freshmen, *M*=3.58, *SD*=.53; for sophomores, *M*=3.66, *SD*=.41; for juniors, *M*=3.74, *SD*=.49; and for seniors, *M*=3.76, *SD*=.51). This case could also be seen for females (for freshmen, *M*=3.61, *SD*=.52; for sophomores, *M*=3.70, *SD*=.36; for juniors, *M*=3.77, *SD*=.46; and for seniors, *M*=3.80, *SD*=.46) The increase in the attitudes and beliefs were noticed for males up to the third year of the program (for freshmen, *M*=3.51, *SD*=.54; for sophomores, *M*=3.56, *SD*=.49; for juniors, *M*=3.69, *SD*=.53), and this increase did not continue for senior males (*M*=3.69, *SD*=.58).

### 4.3. Inferential Statistics

This section contained the inferential statistics which were two-way ANOVA and Pearson product-moment correlation. These analyses were conducted for the aim of seeking the third, the fourth, and the fifth research questions of the study.

#### 4.3.1. The Difference in Turkish Prospective Elementary Mathematics Teachers' KHM and Their ABHME with respect to Year Enrolled in Teacher Education Program and Gender

Two-way ANOVA were performed for investigating both the third and the fourth research questions which were fundamentally asked for exploring a possible difference in Turkish prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education in terms of year enrolled in teacher education program and gender respectively. The underlying assumptions of two-way ANOVA parametric analysis were ensured prior to its implementation.

#### 4.3.1.1. Assumptions of Two-Way ANOVA

In accordance with Pallant's (2007) viewpoint, there were five assumptions appertaining to the parametric statistical technique of two-way ANOVA as level of measurement, random sampling, independence of observations, normal distribution, and homogeneity of variance.

In respect of Pallant's (2007) opinion, the level of measurement of dependent variable(s) should be interval or ratio in parametric statistics. In the study, the dependent variables were Turkish prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education. As mentioned before, these were determined by the participants' mean scores from KHM Test and ABHME Questionnaire. Considering this, it can be stated that the dependent variable related to knowledge and related to attitudes and beliefs were continuous at interval level. Thus, the level of measurement assumption was assured.

Random sampling is also a necessity of benefiting from parametric statistics (Pallant, 2007). It was thought that this second assumption was ensured since the sampling method of the study was clustered random sampling.

According to Pallant (2007), participants of a research should not have an influence on the responses of each other in the implementation procedure This study assumed that such a case did not happen during the data collection process.

In parametric statistical techniques, each group in a study should have a normal distribution of their scores on dependent variable(s) (Pallant, 2007). In this study, these groups were comprised of freshmen, sophomores, juniors, seniors, males, and females. In Table 4.5, skewness and kurtosis values of these six groups' distribution on the two dependent variables, which were the mean knowledge scores on the history of mathematics (KHM) and mean attitudes and beliefs scores towards the use of history of mathematics in mathematics education (ABHME) were given in order to form an idea about the mentioned normality values.

Table 4.5

*Skewness and Kurtosis Values of KHM and ABHME Mean Scores with respect to Year Enrolled in Teacher Education Program and Gender*

| Groups | KHM Mean Scores | | ABHME Mean Scores | | |
|---|---|---|---|---|---|
| | Skewness | Kurtosis | Skewness | Kurtosis | N |
| Freshmen | .13 | .18 | -.93 | 1.97 | 477 |
| Sophomores | -.05 | -.10 | -.83 | 2.06 | 428 |
| Junior | -.05 | -.20 | -1.29 | 3.81 | 410 |
| Senior | -.18 | -.19 | -1.10 | 2.28 | 278 |
| Females | .23 | -.22 | -1.07 | 3.15 | 1064 |
| Males | .08 | -.24 | -.91 | 1.60 | 529 |

In a normal distribution of a group, skewness and kurtosis values should be between -2 and +2 (Kunnan, 1998). When Table 4.5 examined, the kurtosis values of the distribution of juniors', seniors', and females' ABHME mean scores were out of this interval. The high kurtosis values would mean that there would be a peak of mean scores around the mean value of the whole distribution. This situation might be an indicator of the violation of this assumption for these three cases. Yet, these violations did not present a problem due to the large sample sizes (greater than 100) of juniors, seniors, and females which were 410, 278, and 1064 respectively (Pallant, 2007).

The histograms together with their normal curves for KHM and ABHME mean scores' distribution for each of the six groups are presented in Appendix D. The curves drawn based on those histograms supported the normal distribution assumption as well as the skewness and kurtosis values given. In conclusion, it can be claimed that there is no violation of the normality assumption.

The last assumption, that is homogeneity of variance, addresses that "the variability of scores for each of the groups is similar" (Pallant, 2007, p. 204). Levene's Test of Homogeneity of Variance was utilized to check this assumption for each of the two dependent variables, which were KHM mean scores and ABHME mean scores. Both of the two-way ANOVAs generated for the two variables, the test was found to be significant, which meant that the population variances were not equal across the groups (freshmen, sophomores, juniors, seniors, females, and males) (Stevens, 2002). The violation of this assumption caused questioning the robustness of the two generated *F* statistics. In order to ensure the robustness of the *F* statistic, Tabachnic and Fidell (2007) suggested calculating an $F_{max}$ value, which is "the ratio of the largest cell variance to the smallest. If sample sizes are relatively equal (within a ratio of 4 to 1 or less for largest to smallest cell size), an $F_{max}$ value as much as 10 is acceptable." (p. 86). Variances of the groups for KHM and ABHME mean scores are given in the next table.

Table 4.6

*Variances of the Groups for KHM and ABHME Mean Scores*

| | | Freshmen | Sophomores | Juniors | Seniors | Females | Males |
|---|---|---|---|---|---|---|---|
| N | | 477 | 428 | 410 | 278 | 1064 | 529 |
| $\sigma^2$ | KHM | .02 | .02 | .03 | .02 | .03 | .03 |
| | ABHME | .28 | .16 | .24 | .26 | .21 | .29 |

First of all, the maximum value for the ratio of the pairs of group sizes was 3.83 (the groups were females and seniors in this calculation), thus it was appropriate to utilize from $F_{max}$ robustness test. The $F_{max}$ values for homogeneity of variances tests with KHM and ABHME were 1.5 and 1.75 respectively. The values were smaller than 10, which meant the F value was robust (Tabachnic & Fidell, 2007).

After the assumptions of the two-way ANOVA were discussed and ensured, the results from this statistical analysis were examined in research question based steps.

#### 4.3.1.2. Turkish Prospective Elementary Mathematics Teachers' KHM with respect to Year of Enrollment and Gender

The following research question was investigated in order to determine the possible significant mean difference in Turkish prospective elementary mathematics teachers' knowledge of history of mathematics based on the year in the teacher education program and the gender:

Is there a significant mean difference in Turkish prospective elementary mathematics teachers' knowledge of history of mathematics with respect to year enrolled in teacher education program and gender?

First of all, the interaction effect between the two independent variables was examined. According to Pallant (2007), the significance of interaction effect should be initially controlled since the main effects of the each independent variable should be carefully commented if it is significant. The results showed that the mentioned interaction effect between year enrolled in teacher education program and gender was statistically significant [$F(3, 1585) = 4.02$, $p < .05$]. This meant that the influence of year enrolled in the teacher education program on knowledge of the history of mathematics changed for females and males, which meant that an interaction occurred between the year enrolled in the program and the gender. This illustrated in figure 4.2.

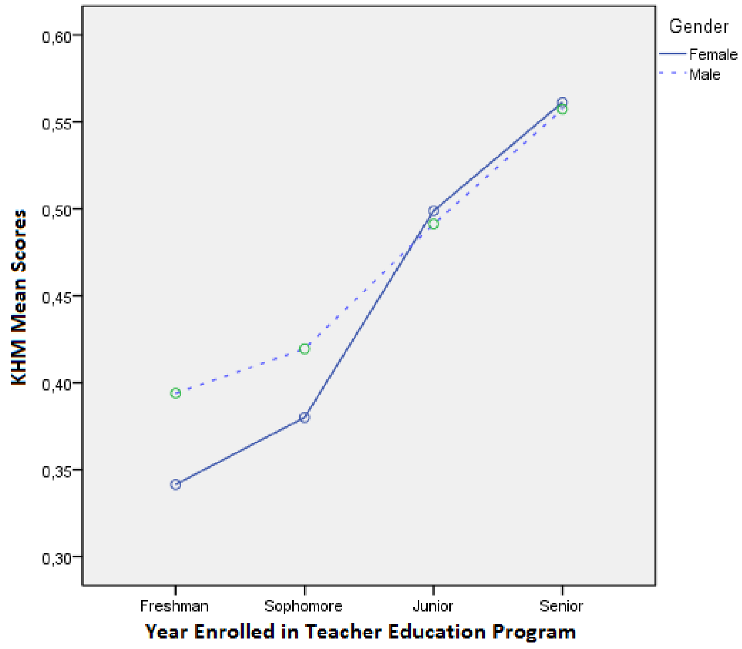


*Figure 4.2* Interaction effect between year enrolled in teacher education program and gender on KHM mean scores

As Figure 4.2 indicated, the male prospective teachers' knowledge of history of mathematics was higher than that of the females in the first and second years in the teacher education program, but the case was reversed in the third and fourth years. Hence, gender seemed to affect the influence of year enrolled in teacher education program on knowledge of history of mathematics.

The main effects of year enrolled in teacher education program and gender resulted in this two-way ANOVA were not examined since an interaction effect emerged. Instead of this, simple main effects, which addressed presenting for one of the independent variables with the categories of the other independent variable, of these two independent variables were investigated. The syntax language of PASW 18 software program was utilized to reveal multiple comparisons of knowledge of history of mathematics mean scores by year enrolled in teacher education program across categories of gender. The results are given in Table 4.7.

Table 4.7

*Multiple Comparisons of KHM Mean Scores by Year Enrolled in Teacher Education Program across Categories of Gender*

| Comparison | | Mean Difference (I-J) | SE | 95% Confidence Interval | |
|---|---|---|---|---|---|
| Gender | Year Enrolled in Teacher Education Program (I vs. J) | | | Lower Bound | Upper Bound |
| Females | Freshman vs. Sophomore | -.039* | .011 | -.069 | -.008 |
| | Freshman vs. Junior | -.157* | .012 | -.189 | -.126 |
| | Freshman vs. Senior | -.220* | .013 | -.255 | -.184 |
| | Sophomore vs. Junior | -.119* | .012 | -.151 | -.087 |
| | Sophomore vs. Senior | -.181* | .014 | -.217 | -.145 |
| | Junior vs. Senior | -.062* | .014 | -.099 | -.025 |
| Males | Freshman vs. Sophomore | -.026 | .017 | -.071 | .020 |
| | Freshman vs. Junior | -.097* | .017 | -.141 | -.054 |
| | Freshman vs. Senior | -.163* | .018 | -.212 | -.115 |
| | Sophomore vs. Junior | -.072* | .017 | -.117 | -.026 |
| | Sophomore vs. Senior | -.138* | .019 | -.188 | -.088 |
| | Junior vs. Senior | -.066* | .018 | -.017 | -.115 |

Considering the results on Table 4.7, it can be stated that the differences between all possible pairs of year enrolled in teacher education program were statistically significant for females. It may be added that as year enrolled in teacher education program increased, knowledge of history of mathematics increased for females. As for male participants, the similar inference with that of females might be made except for the pair between freshman and sophomore. The comparison of these two groups clarified that the increase in male participants' knowledge of history of mathematics across the first and second years enrolled was not statistically significant.

The multiple comparisons of knowledge of history of mathematics mean scores by gender across the categories of year in teacher education program are presented in Table 4.8 in the following page.

Table 4.8

*Multiple Comparisons of KHM Mean Scores by Gender across the Categories of Year Enrolled in Teacher Education Program*

| Comparison | | Mean Difference (I-J) | SE | 95% Confidence Interval | |
|---|---|---|---|---|---|
| Year Enrolled in Teacher Education Program | Gender (I vs. J) | | | Lower Bound | Upper Bound |
| Freshman | Female vs. Male | -.052* | .014 | -.080 | -.025 |
| Sophomore | Female vs. Male | -.039* | .015 | -.069 | -.010 |
| Junior | Female vs. Male | .008 | .015 | -.021 | .036 |
| Senior | Female vs. Male | .004 | .018 | -.031 | .039 |

The results from the comparisons by gender indicated that statistically significant differences existed across the first two years of enrollment in teacher education program. In these two years, females' knowledge of history of mathematics was lower than that of males. For juniors and seniors, females' higher scores were not statistically significant.

#### 4.3.1.3. Turkish Prospective Elementary Mathematics Teachers' ABHME with respect to Year of Enrollment and Gender

The fourth research question was investigated in order to determine the possible significant mean difference in Turkish prospective elementary mathematics teachers' attitudes and beliefs towards the related use of history of mathematics based on the year in the teacher education program and the gender:

Is there a significant mean difference in Turkish prospective elementary mathematics teachers' attitudes and beliefs towards the use of history of mathematics in mathematics education with respect to year enrolled in teacher education program and gender?

With respect to Pallant's (2007) opinion, the interaction effect between year enrolled in teacher education program and gender was initially examined for the dependent variable as attitudes and beliefs towards the use of history of mathematics in mathematics education. The relevant results revealed that the an interaction effect between the two independent variables was not statistically significant [$F(3, 1585) = .24$, $p > .05$]. This finding implied that being female or male did not have an impact upon the role of year enrolled in teacher education program on the attitudes and beliefs towards the use of history of mathematics in mathematics education.

The exploration determined that the main effect of year enrolled in teacher education program on the attitudes and beliefs was statistically significant [$F(3, 1585) = 11.61$, $p < .05$]. The differences and their significance were explored by the help of post hoc test and Tukey's Honestly Significant Difference Test (HSD) results, which are introduced in Table 4.9 in the next page.

Table 4.9

*Multiple Comparisons among Each Subgroup of Year Enrolled in Teacher Education Program*

| Year enrolled in teacher education program | Year enrolled in teacher education program | Mean Difference | Sig. |
|---|---|---|---|
| Freshman | Sophomore | -.08 | .053 |
| | Junior | -.16 | .000* |
| | Senior | -.18 | .000* |
| Sophomore | Junior | -.08 | .073 |
| | Senior | -.10 | .033* |
| Junior | Senior | -.02 | .949 |

Considering Table 4.9 above, it can be claimed that ABHME mean score of freshmen (*M*=3.58, *SD*=.53) was significantly lower than that of juniors (*M*=3.74, *SD*=.49) and that of seniors (*M*=3.76, *SD*=.51). Another statistically significant ABHME mean score difference was aroused between sophomores (*M*=3.66, *SD*=.41) and seniors, where the seniors had higher mean scores from ABHME Questionnaire. Sophomores had higher ABHME mean score than freshmen, but the difference between these two groups was not statistically significant. In addition, the statistically significant differences in ABHME mean scores did not also occur between sophomores and juniors, and those between juniors and seniors. For these three pairs of groups, seniors had the greatest mean scores and freshmen had the lowest.

For the aim of having an idea about the real differences in the examined ABHME mean scores, the effect size for year in the program was investigated. The relevant value was calculated as .021 which indicated small effect size (Cohen, 1988). This meant that in addition to the statistical significance of the found ABHME mean differences between the some group pairs, these results had small practical significance as well.

It was also detected that the main effect of gender on the attitudes and beliefs was statistically significant [$F(1, 1585) = 18.06$, $p < .05$]. In other words, it can be stated that ABHME mean score of females ($M$=3.71, $SD$=.46) were significantly higher than that of males ($M$=3.61, $SD$=.54). Like for the groups of year in the program, small effect size of .01 was found (Cohen, 1988). The calculated effect size value pointed that the results indicating differences had also small practical significance.

The examination of the main effects for year enrolled in teacher education program and gender is presented in Figure 4.3 in the next page. In this figure, the absence of the interaction effect between these two independent variables relevant to ABHME mean scores is observed.

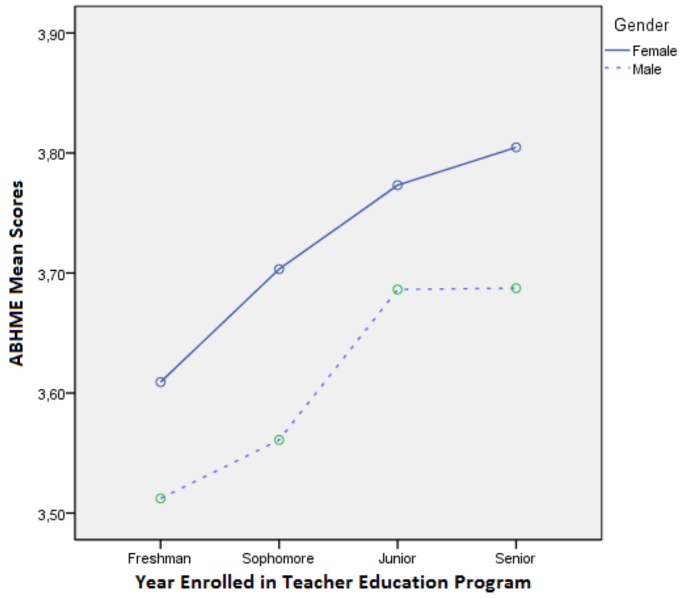


*Figure 4.3* Interaction effect between year enrolled in teacher education program and gender on ABHME mean scores

As Figure 4.3 showed, the female participants' ABHME mean scores were in a trend of increase as the year enrolled in teacher education program increased. This regular increase was not the case for males' ABHME mean scores, which increased in the first three years of the program. The increase almost stopped when in the third year, and the scores nearly remain the same in the fourth year in comparison to the third year.

### 4.3.2. The Relationship between Turkish Prospective Elementary Mathematics Teachers' KHM and Their ABHME

In order to examine the fifth research question, which was asked for clarifying a possible relationship between Turkish prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education, Pearson product-moment correlation analysis was conducted. The analysis also allowed seeing the characteristics of that relationship in details. Before conducting the analysis, the relevant statistical assumptions were assured.

#### 4.3.2.1. Assumptions of Pearson Product-Moment Correlation Analysis

There were five assumptions as level of measurement, related pairs, independence of observations, normal distribution, linearity, and homoscedasticity related to Pearson product-moment correlation analysis, which was a parametric method (Pallant, 2007).

The study had two dependent variables as the mean scores of knowledge of history of mathematics and mean scores of the attitudes and beliefs towards the use of history of mathematics in mathematics education, both of which were continuous at interval level. That meant the level of measurement assumption was provided.

According to Pallant (2007), related pairs of scores on the two variables of correlation for each participant were necessary. There was not any subject whose related scores were missing in the data of the study. Hence, the assumption of related pairs was ensured.

As mentioned before, it was assumed that the participants did not influence each other during the scale implementations, which referred to the independence of observations.

Related to the normal distribution assumption, it was expected that the participants' scores of the two dependent variables were normally distributed. The evaluation of the relevant normality issues were made when the third and fifth research questions were investigated. There was no problem with both of the normal distributions.

Linearity assumption means that there should be a linear relationship between the scores of two variables (Pallant, 2007). Put it differently, the whole drawing obtained by the pairs of scores on each variable should be linear, not curvilinear As for the assumption of homoscedasticity, it refers to "The variability in scores for variable X should be similar at all values of variable Y" (Pallant, 2007, p. 124). With the aim of checking these assumptions, a scatterplot related to the correlation was created and presented in Figure 4.4.

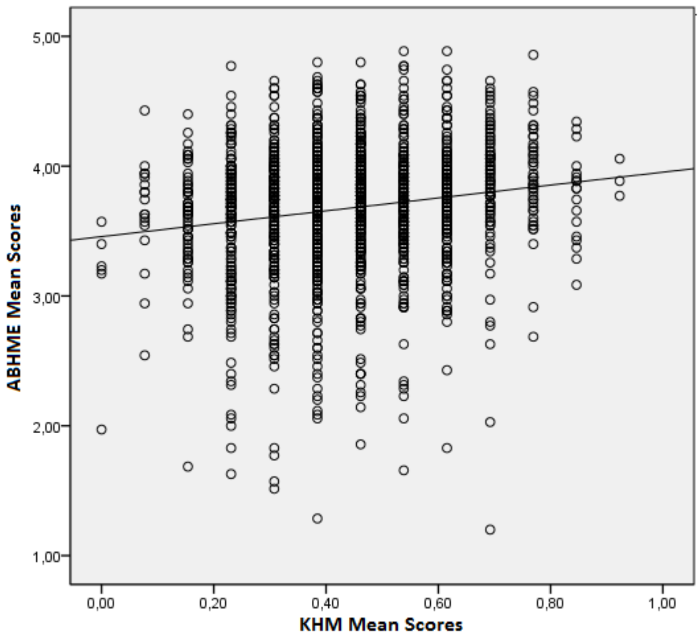


*Figure 4.4* Scatterplot of KHM and ABHME mean scores.

When the scatterplot was considered together with the definitions of the two assumptions being examined, the linear line drawn addressed that the linearity assumption was assured. Additionally, it would be asserted that the linear direction of the relationship was positive because as the KHM mean scores increased, the ABHME mean scores also increased. When the slope of the line considered, it may be forwarded that the relationship was nearly moderate. As for the homoscedasticity assumption, the cigar like shape of the figure indicated that the correlated data pairs were mostly gathered around the linear line, and the second assumption was met.

#### 4.3.2.2. The Relationship between the Prospective Teachers' KHM and Their ABHME

The last research question was investigated in order to determine the possible relationship between Turkish prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the related use of history of mathematics:

Is there a significant relationship between Turkish prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education?

The results of the correlation analysis indicated that there was a positive correlation between Turkish prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education, which was statistically significant ($r$=.18, $p$<.01). In other words, it could be stated that as the prospective teachers' knowledge about the history of mathematics increased, their attitudes and beliefs also increased. The strength of the correlation could be categorized as small (Cohen, 1988). The reason of the significant correlation while it had a small degree was attributed to the greatness of the sample size (Pallant, 2007). The coefficient of determination, which was calculated by squaring the $r$ value as .04, revealed that the two variables shared 4 percent of their variance. That meant the participants' scores on KHM Test explained roughly 4 percent of the variance in their ABHME Questionnaire scores.

### 4.4. Summary of the Results

This research study examined Turkish prospective elementary mathematics teachers' knowledge relevant to the history of mathematics and to examine their attitudes and beliefs towards the use of history of mathematics in the teaching and learning of mathematics. The potential roles of year enrolled in teacher education program and gender on each of these two constructs were also investigated. Moreover, the relationship between the prospective teachers' knowledge of history of mathematics and their attitudes and beliefs in question was analyzed.

According to the analyses results, it can be asserted that Turkish prospective elementary mathematics teachers' knowledge of history of mathematics was moderately low. The teacher candidates' attitudes and beliefs towards the use of history of mathematics in didactics of mathematics were found to be quite high.

The role of year enrolled in teacher education program on the knowledge varied for females and males. More precisely, the superiority of males' knowledge of history of mathematics in their first and second years in the program seemed to be balanced in the third and fourth years. The simple main effect comparisons clarified that females' knowledge of history of mathematics increased significantly as years enrolled in teacher education program increased. Male prospective teachers' knowledge of history of mathematics was on an increase trend for all years in the program and this increase was not statistically significant only in the pair of freshman and sophomores. The simple main effect comparisons by gender showed that the females' knowledge of history of mathematics was significantly lower than that of males in the first and the second years. This situation became reversed in the third and the last years, but the differences were not statistically significant in these years.

About the roles of year enrolled in teacher education program and gender on the prospective teachers' attitudes and beliefs towards the use of history of mathematics in mathematics education, no interaction effect between the independent variables existed. The main effects of these two independent variables, which were year enrolled in teacher education program and gender, were analyzed separately. Year enrolled in teacher education program was found to affect the attitudes and beliefs significantly such that as the year in the program increased, the teacher candidates had higher attitudes and beliefs towards the history of mathematics use. Seniors' attitudes and beliefs were significantly higher than freshmen's and sophomores' attitudes and beliefs. The attitudes and beliefs which juniors had were significantly higher than freshmen's. Females had significantly higher attitudes and beliefs than males. The effect size for these examinations indicated that the results had small practical significance.

The correlation analysis clarified that the prospective teachers' knowledge of history of mathematics and their attitudes and beliefs about the history of mathematics usage were positively correlated. High knowledge of history of mathematics significantly accompanied with high attitudes and beliefs towards using it in the teaching and learning of mathematics.

# CHAPTER 5

# DISCUSSION

In this study, it was aimed to examine prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs about the use of history of mathematics in mathematics teaching and learning with respect to year enrolled in the teacher education program and gender. In addition, the relationship between the teacher candidates' knowledge of history of mathematics and their related attitudes and beliefs were investigated. This chapter discusses the findings based on the research questions, implications for educational practices, and recommendations for future research studies respectively.

## 5.1. Discussion of the Findings

In this part, the findings based on the research questions of the study were discussed considering the relevant existing studies in the literature.

### 5.1.1. The Prospective Teachers' KHM

The results of the study clarified that the prospective elementary mathematics teachers' knowledge of history of mathematics could not be regarded as rich. When the relevant literature reviewed, it was observed that the studies measuring knowledge of history of mathematics were rather limited. In Goodwin's (2007) study, high school mathematics teachers who are offered a course on the history of mathematics had better knowledge of history of mathematics Thus, it may be claimed that the poorness in the prospective elementary mathematics teachers' knowledge of history of mathematics can be attributed to the fewness of the history of mathematics related courses in teacher education program.

In a relevant study with Turkish prospective elementary mathematics teachers, Mehmetlioğlu (2010) clarified that the prospective teachers did not feel themselves highly prepared for their profession. This result can be seen a supportive result for the poorness in their knowledge of history of mathematics. In this study, the freshmen and sophomores did not take courses regarding the history of mathematics whereas the juniors and seniors took. The low knowledge of freshman and sophomore prospective mathematics teachers may have decreased the overall achievement from KHM Test. Thus, there was a variety in prospective teachers' knowledge of history of mathematics based on year of enrollment in teacher education program which will be mentioned further in this chapter.

From the descriptive statistics, more than half of the prospective teachers in the study, precisely freshmen and juniors, stated that they did not take lessons and courses related to or integrated with the history of mathematics in their precollege or university years. Considering this result, the lack of knowledge of history of mathematics in general may be attributed to not being familiar with the history of mathematics when the prospective teachers enter the teacher education program, and also it can be referred to the lack of courses related to the history of mathematics in the first two years of the program. Another result from the descriptive statistics showed that most of the prospective teachers ‘sometimes’ interested in publications included the past of mathematics. The lack of personal interests in history of mathematics may also have an impact upon the low knowledge of history of mathematics that the prospective teachers had.

The study also investigated the possible influence of year enrolled in the teacher education program and gender on Turkish prospective elementary mathematics teachers’ knowledge of history of mathematics. In the literature of history in mathematics education, a close study examining the roles of year enrolled in educational program and gender on knowledge of history of mathematics could not be reached. Therefore, the results of this study presents a new discussion for the mathematics education research, yet should be interpreted cautiously.

The analysis for exploring the roles of year of enrollment and gender on prospective teachers’ knowledge of history of mathematics showed that as year enrolled in teacher education program increased, the prospective teachers’ knowledge of history of mathematics increased. This result can be associated with that the prospective teachers have taken or have been taking the courses of History of Science and History of Mathematics compulsorily in the third and fourth years of the program. Moreover, Işıksal (2005) found that prospective mathematics teachers’ mathematical performance improved accompanying with the increase of year enrolled in teacher education program. The trend of increase in the prospective teachers' knowledge about the history of mathematics also might be related to their improvement in mathematical performance. The rates of increases on the knowledge of history of mathematics differed across years enrolled in teacher education program for both females and males. For females, there was a significant growth in the knowledge of history of mathematics for all consecutive years enrolled in the program. But males' knowledge of history of mathematics was significantly increased between the pairs of second-third and third-fourth years enrolled in the program. The significant increase in knowledge of history of mathematics scores for both female and male prospective elementary mathematics teachers through the years in the teacher education program is in line with Mehmetlioğlu's (2010) finding that prospective elementary mathematics teachers' readiness about their future profession significantly increased from the third to the fourth year in the teacher education program. This result and another parallel result that the increase of the knowledge as passing from freshman through sophomore was not significant can be connected to that the program did only suggest the mentioned history of mathematics related courses in the last two years.

Another result of the study showed that there was a significant interaction between year enrolled in teacher education program and gender with respect to knowledge of history of mathematics such that in the first two years, males' knowledge was significantly higher than that of females. This could be related to males' special interest in the history of mathematics when they entered the teacher education program and in the first two years.

In the last two years of the teacher education program, females' knowledge of history of mathematics was higher than that of males, but the difference was not statistically significant. Işıksal (2005) clarified that female prospective mathematics teachers were better than males in respect of their mathematical performance. Considering that mathematical performance might be related to knowledge of history of mathematics, it can be asserted that Işıksal's (2005) finding was inconsistent with freshman and sophomore male prospective teachers' higher knowledge of history of mathematics in this study. The interaction between year of enrollment and gender on the prospective elementary mathematics teachers' knowledge of history of mathematics might be caused such an inconsistency.

That the knowledge scores on the history of mathematics for males and females balanced in the third and fourth years might be owing to the fact that History of Science and History of Mathematics courses were taken in these two years. The increase in the prospective teachers' familiarity with the teaching materials (such as tangram) of the curriculum through the years enrolled in the program may also contribute to their knowledge of history of mathematics. Additionally, Mehmetlioğlu (2010) stated that there was no significant difference between female and male junior and senior prospective elementary mathematics teachers' preparedness about their future profession which can be linked to the result of this study that there was no significant difference between the female and male junior and senior prospective teachers' knowledge of history of mathematics. In the literature, there were also studies which could not find a mathematics related achievement difference with respect to gender (e.g., Ethington, 1990), or which found such a difference in favor of females or males (e.g., Marshall, 1982; Moore & Smith, 1987). If mathematics related achievement is thought to have parallelism with knowledge of history of mathematics, the change across the years of enrollment in the superiority of knowledge of history of mathematics with respect to gender may be related to that the role of gender on mathematics related achievement is a controversial issue.

### 5.1.2. The Prospective Teachers' ABHME

It was revealed from the descriptive statistics that the prospective teachers had considerably high positive attitudes and beliefs towards the use of history of mathematics. In her study, Oprukçu-Gönülateş (2004) determined a non-significant increase in prospective mathematics teachers' existing attitudes towards the usage of history of mathematics and their related attitudes after an intervention of how to use history of mathematics in mathematics education. She attributed this case to the finding that their existing attitudes were already positive. In a similar experimental study, Gürsoy (2010) also found that prospective elementary mathematics teachers' attitudes and beliefs towards the utilization from history of mathematics were quite high (nearly four out of five) before the implementation of historical activities in the instructional process of his study. The result that Turkish prospective elementary mathematics teachers' attitudes and beliefs towards the use of history of mathematics in mathematics education was found high in the study can be connected to that their existing attitudes and beliefs on the issue was already high (Gürsoy, 2010; Oprukçu-Gönülateş, 2004).

The study examined if Turkish prospective elementary mathematics teachers' attitudes and beliefs towards the use of history of mathematics in mathematics education changed with respect to the year level in the program and gender. The relevant results showed that there was not a statistically significant interaction effect between year enrolled in teacher education program and gender with respect to attitudes and beliefs towards the use of history of mathematics in mathematics education. The attitudes and beliefs significantly increased as year enrolled in teacher education program increased, and females appeared to have significantly higher attitudes and beliefs towards the history of mathematics usage. No study examining the roles of year enrolled in educational program and gender on attitudes and beliefs towards the history of mathematics usage in the literature could be reached, which also strengthens the importance of this study. Hence, the interpretation of the related results was made considering some related studies about attitudes and beliefs conducted with the participation of mathematics teacher candidates.

Regarding the role of year level, Çakıroğlu and Işıksal (2009) found that prospective mathematics teachers' attitudes towards mathematics did not differed according to year enrolled in teacher education program. They also ascertained that the prospective teachers' self-efficacy beliefs about mathematics increased as year of enrollment increased. Işıksal (2005) also explored an increase in prospective mathematics teachers' self-efficacy about mathematics with the increase in year level. In a relevant study, Mehmetlioğlu (2010) found that senior prospective elementary mathematics teachers' readiness regarding their future profession was significantly higher than that of junior prospective elementary mathematics teachers. Considering these studies, it can be claimed that the improvement in prospective teachers' history of mathematics incorporation related attitudes and beliefs across the years enrolled in the program may be due to the increase in their self-efficacy beliefs about mathematics and readiness towards their prospective profession. It might also be due to that juniors and seniors take courses on mathematics education and that seniors take courses on teaching practice. In addition, the courses about history of mathematics (History of Science and History of Mathematics) that are suggested in the last years of the teacher education program might have had an impact upon this increase with the years (HEC, 2007).

The finding of this study that there was not a significant difference between senior and junior prospective mathematics teachers' history of mathematics related attitudes and beliefs may be attributed to that their constructivist and traditional beliefs about mathematics did not differed in these two years (Kayan, 2011). It may also indicate inadequacy in courses on teaching practice such that the prospective teachers might not observe and experience the use of history of mathematics in actual classroom settings.

As for the role of gender on mathematics related beliefs, Çakıroğlu and Işıksal (2009) could not find a difference between prospective mathematics teachers' attitudes toward mathematics with respect to gender. Işıksal (2005) also could not find any gender difference in self-efficacy beliefs about mathematics. In Çakıroğlu and Işıksal's (2009) study, the role of gender on the prospective teachers' self-efficacy beliefs about mathematics was found to be significant such that males' related self-efficacy was higher than that of females. On the other hand, Kayan (2011) explored that female prospective elementary mathematics teachers' constructivist and traditional beliefs regarding mathematics was significantly higher than that of males. Considering the parallelism between this study and that of Kayan's (2011), the result that the females' history of mathematics usage related attitudes and beliefs was higher than that of males may be addressed that prospective elementary mathematics teachers might perceive the historical method matching with constructivist or traditional learning approaches. The relationship between the historical method and constructivist ideas can also be noticed in the literature (e.g., Radford, 1997). The link between the traditional beliefs about mathematics and the attitudes and beliefs towards mathematics may be due to the prospective teachers' possible ideas that the historical method cannot contribute to the classroom mathematics teaching in a different way. This idea may also be connected to the lack of knowledge of the history of mathematics in such a way that if they do not master the historical background knowledge, they cannot effectively use the historical method and this does not result in an improvement in their future teaching. In conclusion, as it can be noticed from the sample studies, the literature showed different findings related to the role of gender factor (Ercikan, McCreith, & Lapointe, 2005). This study was also thought to contribute to the relevant literature with its gender related result.

### 5.1.3. The Relationship between the Prospective Teachers' KHM and Their ABHME

The results regarding a possible relationship between Turkish prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education indicated that there was a positive relationship between prospective teachers' knowledge of history of mathematics and their related attitudes and beliefs. There are many arguments in favor of the relationship between knowledge and attitudes and beliefs in the regarding literature. For example, Thompson (1992) mentioned about "the close connection that exists between beliefs and knowledge" (p. 129). Considering Maker (1982), it can be stated that this relationship is not a one directional. Regarding this issue, Pehkonen and Pietila's (2003) introduced that subjective knowledge (e.g., attitudes, beliefs) had an interaction with objective knowledge (knowledge about formal concepts). In this study, the prospective teachers' subjective knowledge referred to their attitudes and beliefs towards the history of mathematics usage and their objective knowledge addressed to their knowledge of history of mathematics. Considering this relationship, it can be claimed that prospective mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education are likely to enhance each other.

There are also related studies based on practice in the literature, but these were somewhat limited. Among these studies, a positive relationship between public understanding of science and attitudes towards science was explored (Evans and Durant, 1995). Goodwin (2007) investigated that high school teachers had better knowledge of history of mathematics thought that students can rediscover mathematics and that doing mathematics was not intrinsic only to mathematicians. The high school teachers who had high knowledge of history of mathematics also stated that the development of mathematics is a continuing process and that different cultures' marks could be noticed in mathematics (Goodwin, 2007). In conclusion, it can be claimed that the results of the study appeared to be consistent with the arguments and the results of the previous studies presented above.

### 5.2. Implications for Educational Practices

In this section, some implications for educational policy makers, curriculum developers, textbook editors, teacher education programs, and teachers of mathematics were forwarded in accordance with the discussion of the results.

In one of the two items which viewed the prospective teachers' familiarity with history of mathematics, a more than half of them stated that they did not take courses incorporated with history of mathematics. This meant that the prospective teachers studied mathematics in a non-historical way. It also addressed the inadequacy of history of mathematics integration in the courses taken from primary to undergraduate years. This situation was not surprising when it was considered as an example that Turkish elementary mathematics curriculum acquainted with the history of mathematics incorporation at the beginning of 21st century (MoNE, 2005).

In the second familiarity with history of mathematics item, it was determined that majority of them ‘sometimes’ followed publications relevant to history of mathematics and that nearly one third of them ‘never’ followed these publications. This addresses that the prospective teachers’ interests in history of mathematics should be enhanced. For this aim, the number of books, journals, magazines, and documentaries about history of mathematics addressing prospective teachers might be increased. These kinds of publications are ought to be more accessible for all prospective elementary mathematics teachers who are studying in cities located in different geographical regions of the country. For example, university libraries may be provided with such sources and prospective teachers should be encouraged to follow these sources.

Regarding the prospective elementary mathematics teachers’ knowledge of history of mathematics, the findings referred that they had moderately low knowledge. Teachers’ knowledge required for their instruction has a significant role on his/her teaching performance in the classroom and thus on what the students learn (Alexander & Dochy, 1995; Fennema & Franke, 1992). They also stated that teachers’ professional knowledge should be a sophisticated system which includes several elements. Among these elements, the use of history of mathematics in mathematics education can also be placed. If a mathematics teacher aims to integrate history in classroom mathematics, he/she should first acquire necessary knowledge of history of the mathematical subjects (Fried, 2001; Heiede, 1996).

In order to make mathematics teachers knowledgeable about history of mathematics, courses regarding history of mathematics should be studied in pre-service teacher education programs (Furinghetti, 2000). Considering that today's prospective mathematics teachers will be mathematics teachers in the future, the result that their knowledge of history of mathematics was poor should be cautiously considered. One of the claims of this study that history of mathematics related courses help prospective mathematics teachers' knowledge of history of mathematics increase, the existing relevant courses suggested by HEC (2007) may be offered as obligatory courses for training more knowledgeable prospective mathematics teachers in Turkey. HEC (2007) determined that each of these three courses could be taken for one semester among a total of eight semesters in elementary mathematics teacher education program. The courses might be expanded to the whole program in order to contain more comprehensive history of mathematics. Moreover, a course regarding the use of history of mathematics in mathematics education can also be added by HEC (2007) as an elective course for elementary mathematics teacher candidates. By means of such a course, they would become more knowledgeable on mathematics' history which would be necessary before using it in mathematics education (Fried, 2001). The prospective teachers' knowledge of history of mathematics can also be promoted if university teachers, who offer the mathematics content courses for the prospective mathematics teachers, would also include the historical origins of the mathematical concepts into these courses. Such inclusions are likely to contribute to the teacher candidates' knowledge of the history of mathematics. Furthermore, mathematics teacher candidates should be given opportunity to participate in additional activities like seminars and symposium about history of mathematics during their pre-service training. University teachers and experts of the field should take responsibility in arranging these meetings and encouraging their future mathematics teachers for attendance.

The prospective mathematics teachers' attitudes and beliefs towards the use of history of mathematics in mathematics education was found relatively high. Since teachers' attitudes and beliefs affect their classroom actions and behaviors and vice versa (Ajzen, 2001; Ajzen & Fishbein, 1977; Ernest, 1988; Glasman & Albarracin, 2006; Kallgren & Wood, 1986; Richardson, 1996), this high attitudes and beliefs might be indicating that they were open to use this alternative method in their future professional life. Thus, they should be maintained by the prospective teachers during their pre-service education years and also during their professional life. Considering the positive correlation found between knowledge of history of mathematics and history of mathematics related attitudes and beliefs, supporting the prospective teachers' learning of history of mathematics when they start the teaching profession may be one of the ways of maintaining positive attitudes and richer beliefs.

In order to keep the prospective teachers' history of mathematics related attitudes and beliefs high, in-service training programs may be arranged by Ministry of National Education in the future for improving their use of history of mathematics. The prospective teachers should be equipped with enough resources such as books and guides for how to use history in mathematics education, books on history of mathematics, and historical teaching materials in order to make their positive history of mathematics related attitudes and beliefs into practice and to keep these attitudes and beliefs high. Though prospective teachers' attitudes and beliefs towards the history of mathematics integration was high and the fact that there was no special course on how to use history in mathematics education (HEC, 2007), mastering how to engage history of mathematics with mathematics teaching seemed to be depended on the opportunities of teacher education programs would provide such as placing to this method in their courses such as History of Mathematics, or Methods of Teaching Mathematics. The lack of a course precisely on the use of history in mathematics education should also be reconsidered by the teacher education programs and HEC.

Due to the result that there was a significant relationship between prospective elementary mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education, it can be claimed that these two constructs affect each other and increase in one result an increase in the other. In addition, a mathematics teacher's high attitudes and beliefs towards the history of mathematics integration may fail if he/she does not have the relevant history of mathematics background knowledge. Hence, both these two components in prospective teachers' professional repertoire should be attended and improved.

### 5.3. Recommendations for Further Research

In this study, the data were obtained from prospective teachers in all possible four years in the elementary mathematics teacher education program in the fall semester of 2010-2011 academic year of education. The changes in mathematics teacher candidates' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education as year enrolled in teacher education program increases might also be investigated in a longitudinal project (Kagan, 1992). In such a longitudinal study, the same participant group may give a better idea about the changes in and the relationship between knowledge of history of mathematics and the related attitudes and beliefs. Because, the possible effect of individual differences is expected to reduce with the same participants. The role of possible factors (like whether taking or not taking a course related to the past of mathematics) on knowledge of history of mathematics and attitudes and beliefs towards the use of history of mathematics in mathematics education can be researched as well.

A qualitative study for an in depth examination of the results of this study might be conducted as a follow up work in order to grasp a more detailed image of the responses in this study and to see the reasons of the results. According to McLeod (1992), different research designs should be used for better enhancing affective factors in mathematics education. Hence, studies with mixed research designs using both quantitative and qualitative instruments should also be done. Depending on just one kind of instrument may distort the actual situation (Thompson, 1992).

The studies examining prospective and in-service teachers' knowledge of history of mathematics were rather limited in the literature. Therefore, considering the importance of using history of mathematics in mathematics education and the necessity of teachers' mastery to the relevant historical knowledge, researchers should continue similar studies with different participant groups in several cultural contexts. Similarly, the relationship between knowledge of history of mathematics and attitudes and beliefs towards the use of it in mathematics teaching and learning is could be studied with various instruments and research designs.

For having information about prospective mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards the use of history of mathematics in mathematics education, KHM Test and ABHME Questionnaire were used respectively. As mentioned before, Turkish national upper elementary (K6-8) mathematics curriculum (MoNE, 2009) and its formal textbooks (Durmuş, 2010a, 2010b, 2010c) were considered in the development of KHM Test. For the future, some other sources in addition to the new versions of the curriculum and textbooks should be reconsidered for improving KHM Test or developing new comprehensive knowledge of history of mathematics tests. For ABHME Questionnaire, the items were created considering some certain aspects like self-efficacy about utilizing from the history of mathematics in mathematics teaching. By combining the literature of using history in mathematics education, new aspects and their corresponding items can be added to the questionnaire. A new version of the questionnaire may also be formed.

In Hatisaru and Çetinkaya's (2011) research, in-service high school mathematics teachers stated that they did not believe the method's possible contributions to students' mathematical thoughts, and they did not use the history of mathematics in their instruction. Therefore, the prospective elementary mathematics teachers would be studied in terms of their beliefs and attitudes towards the use of history of mathematics in the classroom and how these beliefs would change could be investigated in the following years. Moreover, though prospective mathematics teachers showed positive attitudes and beliefs about the history of mathematics integration, they may not reflect them in their future mathematics classroom teaching due to some reasons such as those sourced from educational environment or their existing attitudes and beliefs can be reorganized with their classroom experiences (Thompson, 1992). Thus, the prospective teachers' classroom actions related to the use of history of mathematics should be observed in the future. Their requirements about related resources, textbooks, teaching materials, and also in-service training may be detected in these observations.

Finally, in order to have an idea about familiarity with the history of mathematics and attitudes and beliefs towards its usage in actual mathematics classroom settings, further qualitative and qualitative studies should be conducted with prospective teachers as the audience who will take history integrated mathematics courses and in-service mathematics teachers who will use the alternative method of incorporating history of mathematics. The results and findings of these studies are likely to give constructive feedbacks to curriculum developers and mathematics textbooks' editors.

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# APPENDICES

# APPENDIX A

# KNOWLEDGE OF HISTORY OF MATHEMATICS (KHM) TEST

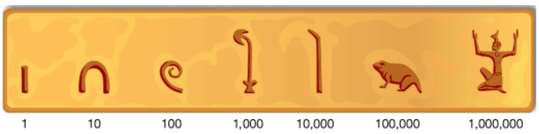
# MATEMATİK TARİHİ BİLGİ TESTİ

Bu test çoktan seçmeli, doğru-yanlış ve boşluk doldurmalı toplam 11 sorudan oluşmaktadır. Testin tamamlanması için öngörülen süre yaklaşık **10 dakika**dır.

**1'den 4'e kadar olan sorular çoktan seçmeli sorulardır. Size en yakın gelen cevabı işaretlemeniz beklenmektedir.**

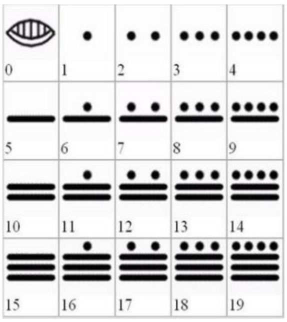
**1.** **-** Bilinen en eski sayma sistemlerinden birine sahiptir.

- Yaklaşık 5000 yıl önce milyona kadar olan bir sayı sistemi geliştirmişlerdir.
- Rakam ve sayılar bazı sembollerin yan yana getirilmesi ile oluşur.
- Sayma sistemlerini oluşturan 7 farklı sembol aşağıda verilmiştir:




Yukarıda bazı özellikleri verilen medeniyet aşağıdakilerden hangisidir?

**A)** Mezopotamya Medeniyeti
**B)** Roma Medeniyeti
**C)** Mısır Medeniyeti
**D)** Babil Medeniyeti (Doğru cevap **C** )

**2.** 


Yandaki tabloda belirtildiği gibi sadece , — ve • 'den oluşan sayı sistemini kullanmış olan eski medeniyet aşağıdakilerden hangisidir?

**A)** Mısır Medeniyeti
**B)** Maya Medeniyeti
**C)** Babil Medeniyeti
**D)** Mezopotamya Medeniyeti

(Doğru cevap **B** )

**3.** 

π sayısıyla ilgili olarak aşağıdaki önermelerden hangisi ya da hangileri <u>yanlıştır</u> ?

**i.** Yaklaşık 4000 yıldan beri çember ve daire ile ilgili hesaplamalarda kullanılır.

**ii.** Tarih boyunca birçok dönemde farklı medeniyetler tarafından farklı değerlerde hesaplanmıştır.

**iii.** Yapılan araştırmalar sonucunda ondalık kısmının belirli bir düzene sahip olduğu bulunmuştur.

**A)** Yalnız iii **B)** i ve ii **C)** i ve iii **D)** Hepsi

(Doğru cevap **A**)

**4.** 

**i.** Türkiye Cumhuriyeti'nde bilimsel terimlerin Türkçeleştirilmesinde ilk adımı atmıştır.

**ii.** 'Geometri' adlı –şu an TDK tarafından satışta tutulan- kitabında çizgi, çember, paralel, üçgen gibi birçok terimi tanımlayarak örneklendirmiştir.

**iii.** Cebir konusundaki çalışmalarıyla dünyaca ün kazanmıştır.

Yukarıda Atatürk hakkında verilen önermelerden hangisi ya da hangileri doğrudur?

**A)** Yalnız ii **B)** i ve ii **C)** i ve iii **D)** Hepsi

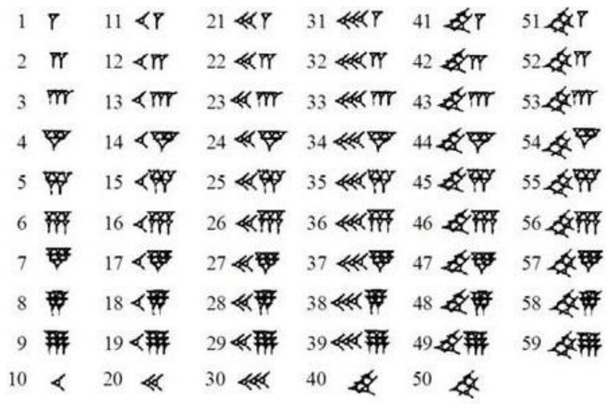
(Doğru cevap **B**)

**5. ve 6. sorular doğru-yanlış sorularıdır. Önerme doğru ise 'D', yanlış ise 'Y' harfini işaretleyiniz.**

**5.** D Y Dünya'nın değişik bölgelerinde yaşayan insanlar uzun yıllar yalnız doğal sayıları kullanmıştır. Zamanla doğal sayılar ve tam sayıların ölçüm işlerinde yetersiz kaldığı anlaşılınca bir ihtiyaç olarak rasyonel sayılar ortaya çıkmıştır.

(Doğru Cevap **D**)

**6.** D Y Aşağıda 1'den 59'a kadar sayıları verilen ve 𒁹 ile 𒌋 sembollerini kullanan eski medeniyet Babil Medeniyetidir.



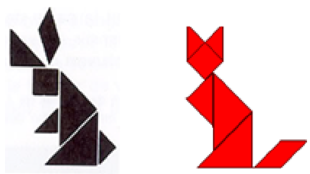
(Doğru cevap **D**)

**7'den 11'e kadar olan sorular boşluk doldurmalı ve kısa cevaplı sorulardır. Boş bırakılan yerleri en uygun ve kısa biçimde yanıtlayınız.**

**7.** **i.** Eski bir Çin bulmacası olan,

**ii.** 7 adet düzgün geometrik şekilden (5 üçgen, 1 kare ve 1 paralelkenar) oluşan,

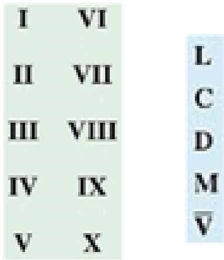
**iii.** Parçaları bir araya getirilerek aşağıdaki gibi 7000'den fazla değişik şekil elde edilebilen bu tarihsel öğretim materyalinin adı nedir?



.........................................

(Doğru cevap **Tangram**)

**8.** Yandaki tabloda kullanmış oldukları sayı sembolleri verilen medeniyet hangisidir?




.................................................

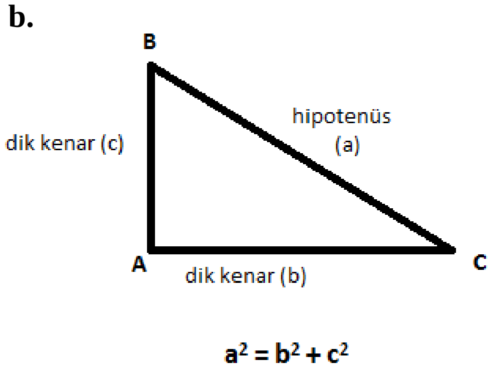
(Doğru cevap **Roma Medeniyeti**)

**9.** Aşağıda verilen desen ve matematiksel ilişkinin size çağrıştırdığı ünlü matematikçinin ismini (özgün dilinde veya Türkçe okunuşu ile) bırakılan boşluğa yazınız.

**a.**

................................................

**b.**




.............................................

(Doğru cevaplar a. **Escher**, b. **Pisagor**)

**10.** **i.** Kökeni, bu konu ile uğraşan ilk kişi olduğu kabul edilen ve İznik'te yaşamış olan Hipparchus (M.Ö. 170 M.Ö.125) tarafından M.Ö. 2. yüzyılda atılmıştır.

**ii.** İsmi, Yunanca 'üçgen' ve ölçüm' anlamına gelen sözcüklerin birleşiminden oluşmuştur.

**iii.** Mısırlılar ve Babilliler, arazi ölçümlerinde, yapılarda, astronomide ve güneş saatinde ondan yararlanmışlardır.

Yukarıda hakkında tarihsel bilgi verilen matematik dalı hangisidir?

............................................................... (Doğru cevap **Trigonometri**)

**11. sorunun a. ve b. şıklarında biyografisine değinilen resimdeki ünlü matematikçiyi bulunuz.**

**11.**

**a.**

M.S. 17. yüzyılda yaşamış bir Fransız matematikçidir. Modern olasılıklar teorisinin temelini atmıştır. Konikler ve projektif geometri üzerinde de çalışmıştır. Babasının vergi toplamasına yardım etmek için ilk dijital hesap makinesini icat etmiştir. İsmininin akıllarda kalmasına neden olan, sayılardan oluşan bir üçgen üzerinde oldukça zaman harcamıştır. Bu üçgeni daha önce Ömer Hayyam bulmuş olup, Hayyam'dan önce de Çinlilerin bu bilgiye sahip olduğu düşünülmektedir.

Bu matematikçi kimdir?
....................................................

**b.**

M.S. 12-13. yüzyıllarda yaşamış bir İtalyan matematikçidir. Ünlü kitabının adı 'Liber abaci' ('Hesap kitabı') dir. Onu en iyi hatırlatan üzerinde çalıştığı sayı dizisidir. Her sayısı kendinden hemen önce gelen ardışık iki sayının toplamına eşit olan bu dizi doğada pek çok canlının yapısında şaşırtıcı bir biçimde karşıya çıkar. Ayrıca yaşadığı dönemde Hint-Arap sayılarını Avrupa'ya tanıtmıştır.

Bu matematikçi kimdir?
.....................................................

(Doğru cevaplar a. **Pascal**, b. **Fibonacci**)

# APPENDIX B

# ATTITUDES AND BELIEFS TOWARDS THE USE OF HISTORY OF MATHEMATICS IN MATHEMATICS EDUCATION (ABHME) QUESTIONNAIRE

# MATEMATİK TARİHİNİN MATEMATİK EĞİTİMİNDE KULLANILMASINA YÖNELİK TUTUM VE İNANIŞLAR ANKETİ

**KİŞİSEL BİLGİLER**

**1. Cinsiyet:** Erkek (1) Bayan (2)

**2. Sınıf:** (1) (2) (3) (4)

**3. Mezun Olunan Lise Türü:**

(1) Anadolu Öğretmen Lisesi (4) Genel Lise

(2) Anadolu Lisesi (5) Diğer

(3) Yabancı Dil Ağırlıklı Lise

**4. Öğrenim yaşantınızda aldığınız matematik derslerinde matematik tarihinden bahsedildi mi?**

Bahsedilmedi (1) Bahsedildi (2)

**5. Matematik tarihi içerikli yayınları (dergi, kitap, belgesel vb.) hangi sıklıkla takip edersiniz?**

Hiçbir zaman (1) Bazen (2) Çoğunlukla (3) Daima (4)

Bu anket 35 maddeden oluşmaktadır. Lütfen anket maddelerine ne derece katılıp katılmadığınızı uygun kutucuğa işaretleyiniz.

| | **Kesinlikle Katılmıyorum** | **Katılmıyorum** | **Kararsızım** | **Katılıyorum** | **Kesinlikle Katılıyorum** |
|---|---|---|---|---|---|
| 1. Matematik tarihi ile matematik eğitimini bütünleştirmek zordur. | | | | | |
| 2. Matematik tarihi hakkında bilgi sahibi olmak, matematiğe neden ihtiyaç duyulduğuna dair fikir verir. | | | | | |
| 3. Matematik eğitiminde matematik tarihinden yararlanılması, farklı bir bakış açısı ve sunuş biçimi sağlamasıyla matematiği öğrenmeye olumlu katkı sağlar. | | | | | |
| 4. Matematik tarihinin matematik derslerinde kullanılması, öğrencilerin matematikten soğumalarına neden olur. | | | | | |
| 5. Tarihteki ünlü matematikçilerin bile matematikle uğraşırken hata yaptıklarını görmek, öğrencilerin matematik öğrenmeye yönelik motivasyonlarını artırır. | | | | | |
| 6. Matematiğin tarihini öğrenmek, öğretmen adaylarının mesleki birikimlerini zenginleştirir. | | | | | |
| 7. Öğretmen adaylarına matematik tarihini verecekleri eğitimde nasıl kullanacakları ile ilgili dersler verilmelidir. | | | | | |
| 8. Matematik tarihi matematiksel kavramları birbirine bağlamamızı ve bunların arasındaki yakın ilişkileri görmemizi sağlar. | | | | | |
| 9. Matematik tarihi sunduğu alternatif yaklaşımlar ve birçok örnek ile öğrencilerin matematik konularını derinlemesine anlamasına yardımcı olur. | | | | | |
| 10. Matematik tarihi öğrencilere matematiğin birçok farklı kültürün evrensel bir ürünü olduğunu fark ettirir. | | | | | |

| | Kesinlikle Katılmıyorum | Katılmıyorum | Kararsızım | Katılıyorum | Kesinlikle Katılıyorum |
|---|---|---|---|---|---|
| 11. Matematik tarihi kaynaklı öğretim araç-gereçlerini nasıl kullanacağım hakkında bir fikrim yok. | | | | | |
| 12. Matematik tarihinin matematik öğretim sürecine nasıl entegre edileceğini bilmiyorum. | | | | | |
| 13. Matematik tarihiyle bütünleştirilmiş matematik eğitimi, öğrencilere matematiğin ne olduğuna dair daha gerçek ve kapsamlı bir görüntü sunar. | | | | | |
| 14. Matematik tarihinden seçilen gerçek hayat problemleri ilköğretim matematik eğitiminde kullanılmalıdır. | | | | | |
| 15. Matematik tarihi matematik öğretmek için kullanışlı bir araçtır. | | | | | |
| 16. Matematik tarihi matematik eğitimine entegre edilmelidir. | | | | | |
| 17. Gelecekte öğreteceğim matematik konularının tarihsel gelişimleri hakkında yeterli bilgiye sahip değilim. | | | | | |
| 18. Matematik tarihinden yararlanılarak matematik dersleri için yazılı ve görsel öğretim araçları geliştirilebilir (Ör. Çalışma yaprağı, oyun, yapboz, belgesel, çizgi film...). | | | | | |
| 19. Matematik tarihi, matematiğin toplumdaki yeri ve önemini anlamaya yardımcı olur. | | | | | |
| 20. Öğretmenin derslerde matematik tarihine yer vermesi, öğrencilerin matematik kaygılarını artırır. | | | | | |
| 21. Matematik tarihini matematik derslerine dahil etmek matematik öğretimini aksatır. | | | | | |
| 22. Matematik tarihi öğrencilerin kendi yetenek ve deneyimlerini kullanarak matematiği yeniden keşfetmelerine olanak sağlar. | | | | | |
| 23. Matematik tarihinin ilköğretim matematik programıyla bütünleştirilmesi, öğrenci ve öğretmenlerin yükünü artırır. | | | | | |

| | Kesinlikle Katılmıyorum | Katılmıyorum | Kararsızım | Katılıyorum | Kesinlikle Katılıyorum |
|---|---|---|---|---|---|
| 24. Matematiğin eski kaynaklarının incelenmesi, hem öğretmenlerin hem de öğrencilerin modern matematiğin avantajlarını görmesine olanak tanır. | | | | | |
| 25. Matematik tarihinden yola çıkılarak geliştirilecek öğretim etkinlikleri sınıf ortamında öğrencilerin ilgisini çekmeyecektir. | | | | | |
| 26. Matematik tarihi sınıf ortamının bilgi aktarılan bir yer olmaktan çıkıp araştırma yapılan bir yere dönüşmesine yardım eder. | | | | | |
| 27. İlköğretim matematik programına matematik tarihinden yola çıkılarak hazırlanmış etkinlikler dahil edilmelidir. | | | | | |
| 28. Öğretmen adayları, matematik kavramlarının tarihsel gelişimi hakkında bilgi ve fikir sahibi olmalıdırlar. | | | | | |
| 29. Matematik tarihinin ilköğretim matematik programında nasıl yer aldığını bilmiyorum. | | | | | |
| 30. Matematik tarihi, matematiğin diğer disiplinlere (Ör. Fizik) olan katkılarını ve onlarla içerisinde bulunduğu yakın ilişkiyi görmemizi sağlar. | | | | | |
| 31. Matematik kavramlarının eski ve modern matematikteki ele alınışlarının karşılaştırılması, öğrencilerin kavramları anlamasına yardım eder. | | | | | |
| 32. Matematik tarihinden yola çıkılarak hazırlanmış öğretim etkinliklerini derslerimde kullanmayı düşünmüyorum. | | | | | |
| 33. Matematik tarihi kaynaklı öğretim araç-gereçlerini matematik derslerinde kullanmak zaman kaybına neden olur. | | | | | |
| 34. İşlenen matematiksel konunun tarihsel gelişimi hakkında bilgi sahibi olmak, öğrencilerin o konuyu daha iyi öğrenmesini sağlar. | | | | | |
| 35. Matematik tarihinin matematik derslerinde kullanımı önemli değildir. | | | | | |

# APPENDIX C

## FACTOR MATRIX OF ABHME ITEMS IN THE PILOT STUDY

| Item | Component | | |
|---|---|---|---|
| | Positive ABHME | Negative ABHME | SBHME |
| 13. Matematik tarihiyle bütünleştirilmiş matematik eğitimi, öğrencilere matematiğin ne olduğuna dair daha gerçek ve kapsamlı bir görüntü sunar. | **.735** | .161 | .037 |
| 6. Matematiğin tarihini öğrenmek, öğretmen adaylarının mesleki birikimlerini zenginleştirir. | **.682** | .169 | .212 |
| 27. İlköğretim matematik programına matematik tarihinden yola çıkılarak hazırlanmış etkinlikler dahil edilmelidir. | **.645** | .301 | -.174 |
| 9. Matematik tarihi sunduğu alternatif yaklaşımlar ve birçok örnek ile öğrencilerin matematik konularını derinlemesine anlamasına yardımcı olur. | **.615** | .046 | -.220 |
| 31. Matematik kavramlarının eski ve modern matematikteki ele alınışlarının karşılaştırılması, öğrencilerin kavramları anlamasına yardım eder. | **.608** | .143 | -.112 |
| 2. Matematik tarihi hakkında bilgi sahibi olmak, matematiğe neden ihtiyaç duyulduğuna dair fikir verir. | **.595** | .052 | .202 |
| 16. Matematik tarihi matematik eğitimine entegre edilmelidir. | **.590** | .279 | -.224 |
| 7. Öğretmen adaylarına matematik tarihini verecekleri eğitimde nasıl kullanacakları ile ilgili dersler verilmelidir. | **.586** | .125 | .057 |
| 8. Matematik tarihi matematiksel kavramları birbirine bağlamamızı ve bunların arasındaki yakın ilişkileri görmemizi sağlar. | **.576** | .092 | .018 |

(continued)

| Item | Component | | |
|---|---|---|---|
| | Positive ABHME | Negative ABHME | SBHME |
| 34. İşlenen matematiksel konunun tarihsel gelişimi hakkında bilgi sahibi olmak, öğrencilerin o konuyu daha iyi öğrenmesini sağlar. | **.571** | .314 | -.224 |
| 24. Matematiğin eski kaynaklarının incelenmesi, hem öğretmenlerin hem de öğrencilerin modern matematiğin avantajlarını görmesine olanak tanır. | **.562** | .080 | -.012 |
| 19. Matematik tarihi, matematiğin toplumdaki yeri ve önemini anlamaya yardımcı olur. | **.562** | .053 | .223 |
| 28. Öğretmen adayları, matematik kavramlarının tarihsel gelişimi hakkında bilgi ve fikir sahibi olmalıdırlar. | **.560** | .148 | -.013 |
| 3. Matematik eğitiminde matematik tarihinden yararlanılması, farklı bir bakış açısı ve sunuş biçimi sağlamasıyla matematiği öğrenmeye olumlu katkı sağlar. | **.527** | .237 | .089 |
| 30. Matematik tarihi, matematiğin diğer disiplinlere (Ör. Fizik) olan katkılarını ve onlarla içerisinde bulunduğu yakın ilişkiyi görmemizi sağlar. | **.520** | .070 | -.082 |
| 5. Tarihteki ünlü matematikçilerin bile matematikle uğraşırken hata yaptıklarını görmek, öğrencilerin matematik öğrenmeye yönelik motivasyonlarını artırır. | **.520** | .094 | .046 |
| 26. Matematik tarihi sınıf ortamının bilgi aktarılan bir yer olmaktan çıkıp araştırma yapılan bir yere dönüşmesine yardım eder. | **.516** | .138 | -.096 |
| 10. Matematik tarihi öğrencilere matematiğin birçok farklı kültürün evrensel bir ürünü olduğunu fark ettirir. | **.515** | .070 | .160 |

(continued)

| Item | Component | | |
|---|---|---|---|
| | Positive ABHME | Negative ABHME | SBHME |
| 22. Matematik tarihi öğrencilerin kendi yetenek ve deneyimlerini kullanarak matematiği yeniden keşfetmelerine olanak sağlar. | **.515** | .219 | -.149 |
| 18. Matematik tarihinden yararlanılarak matematik dersleri için yazılı ve görsel öğretim araçları geliştirilebilir (Ör. Çalışma yaprağı, oyun, yapboz, belgesel, çizgi film...). | **.478** | .063 | .088 |
| 15. Matematik tarihi matematik öğretmek için kullanışlı bir araçtır. | **.468** | .320 | -.228 |
| 14. Matematik tarihinden seçilen gerçek hayat problemleri ilköğretim matematik eğitiminde kullanılmalıdır. | **.446** | .153 | .049 |
| * Matematik dersi matematik tarihi olmadan tekdüze bir ders olur. | **.436** | **.356** | -.261 |
| * Matematik öğretmeni yetiştiren lisans programlarında matematik tarihi ile ilgili dersler zorunlu olarak okutulmalıdır. | **.409** | **.390** | -.054 |
| 21. Matematik tarihini matematik derslerine dahil etmek matematik öğretimini aksatır. | .187 | **.723** | .033 |
| 33. Matematik tarihi kaynaklı öğretim araç-gereçlerini matematik derslerinde kullanmak zaman kaybına neden olur. | .160 | **.711** | .017 |
| 20. Öğretmenin derslerde matematik tarihine yer vermesi, öğrencilerin matematik kaygılarını artırır. | .124 | **.685** | -.041 |
| 35. Matematik tarihinin matematik derslerinde kullanımı önemli değildir. | .137 | **.643** | -.116 |

(continued)

| Item | Positive ABHME | Negative ABHME | SBHME |
|---|---|---|---|
| | Component | | |
| 25. Matematik tarihinden yola çıkılarak geliştirilecek öğretim etkinlikleri sınıf ortamında öğrencilerin ilgisini çekmeyecektir. | .123 | **.631** | .025 |
| 32. Matematik tarihinden yola çıkılarak hazırlanmış öğretim etkinliklerini derslerimde kullanmayı düşünmüyorum. | .279 | **.625** | -.124 |
| 4. Matematik tarihinin matematik derslerinde kullanılması, öğrencilerin matematikten soğumalarına neden olur. | .134 | **.537** | -.029 |
| 23. Matematik tarihinin ilköğretim matematik programıyla bütünleştirilmesi, öğrenci ve öğretmenlerin yükünü artırır. | -.023 | **.501** | .101 |
| * Öğretmen adaylarının matematik tarihini öğrenmesi mesleki gelişimleri açısından önem taşımaz. | **.351** | **.442** | -.016 |
| 1. Matematik tarihi ile matematik eğitimini bütünleştirmek zordur. | .143 | **.414** | .132 |
| 17. Gelecekte öğreteceğim matematik konularının tarihsel gelişimleri hakkında yeterli bilgiye sahip değilim. | .078 | .044 | **.712** |
| 29. Matematik tarihinin ilköğretim matematik programında nasıl yer aldığını bilmiyorum. | .101 | -.022 | **.684** |
| 11. Matematik tarihi kaynaklı öğretim araç-gereçlerini nasıl kullanacağım hakkında bir fikrim yok. | -.113 | .119 | **.583** |
| 12. Matematik tarihinin matematik öğretim sürecine nasıl entegre edileceğini bilmiyorum. | -.018 | .078 | **.570** |

(continued)

| Item | Component | | |
| --- | --- | --- | --- |
| | Positive ABHME | Negative ABHME | SBHME |
| * Eski uygarlıkların kullanmış oldukları matematikleri (Ör. Mısır Matematiği) matematik eğitimine entegre edebilecek kadar bilgiliyim. | -.123 | **.155** | -.528 |
| * İlköğretim öğrencilerine matematik tarihi ile ilgili kapsamlı araştırma projeleri verilmelidir. | **.230** | **.322** | -.373 |

# APPENDIX D

# HISTOGRAMS FOR KHM AND ABHME MEAN SCORES OF FRESHMEN, SOPHOMORES, JUNIORS, SENIORS, FEMALES AND MALES

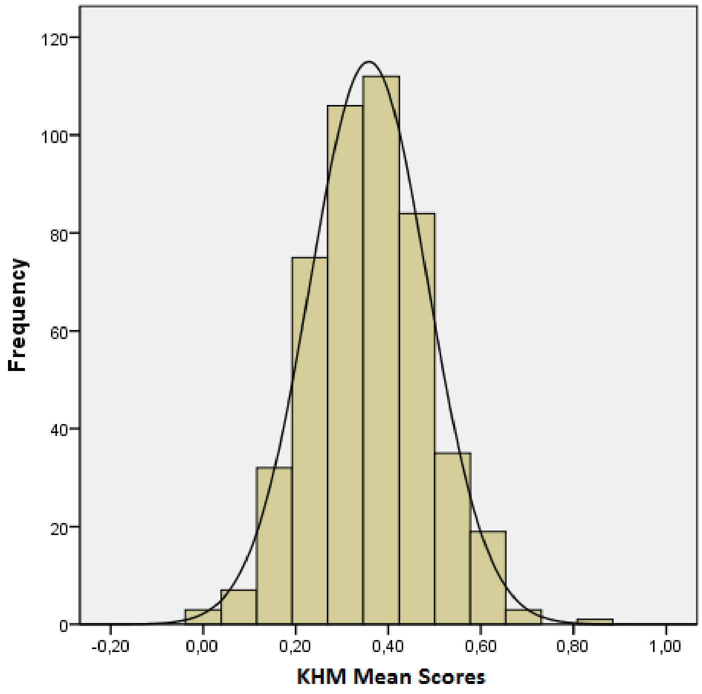



*Figure A.1* Histogram of KHM mean scores of freshmen.

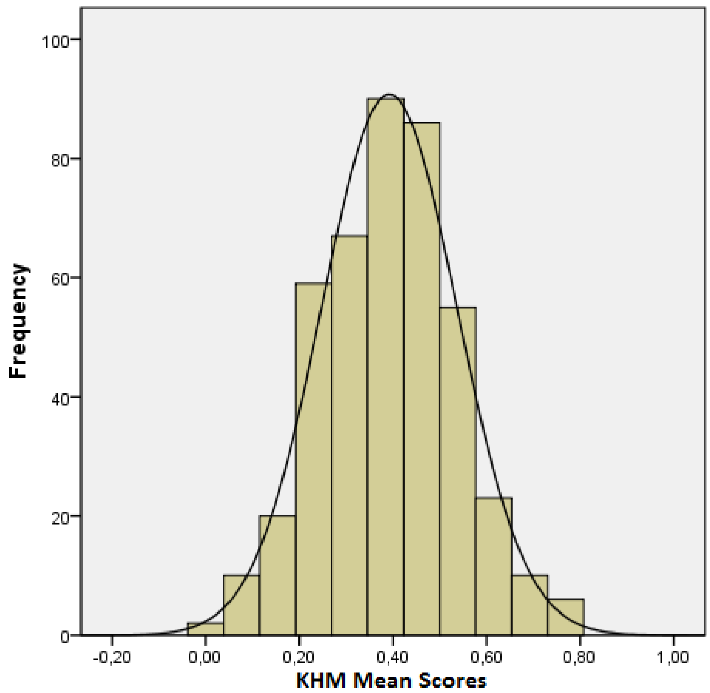



*Figure A.2* Histogram of KHM mean scores of sophomores.

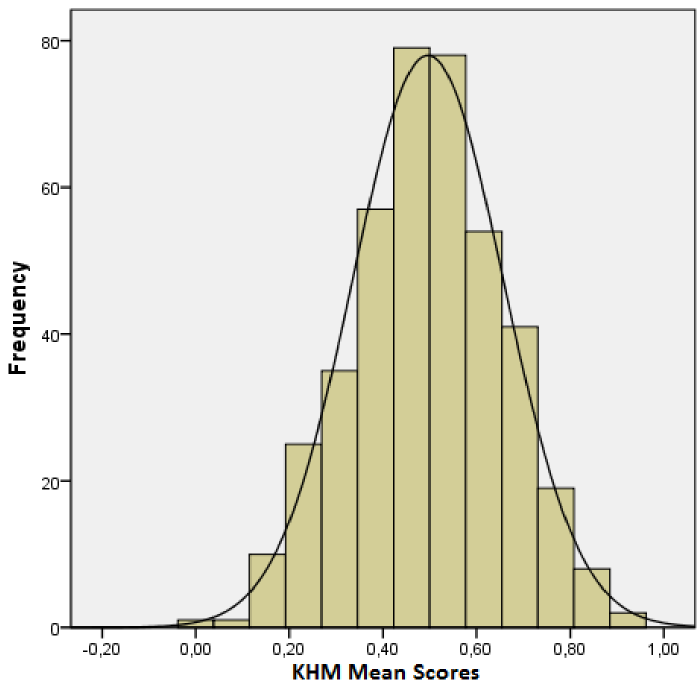



*Figure A.3* Histogram of KHM mean scores of juniors.

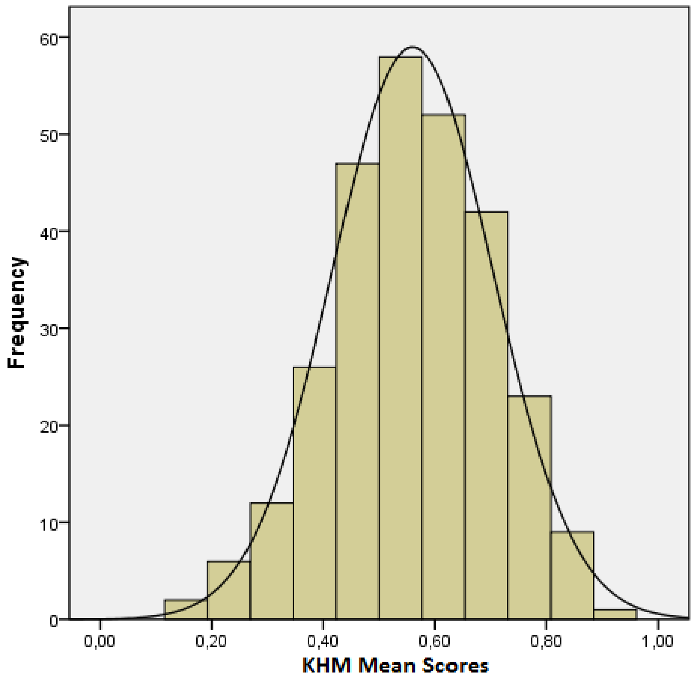



*Figure A.4* Histogram of KHM mean scores of seniors.

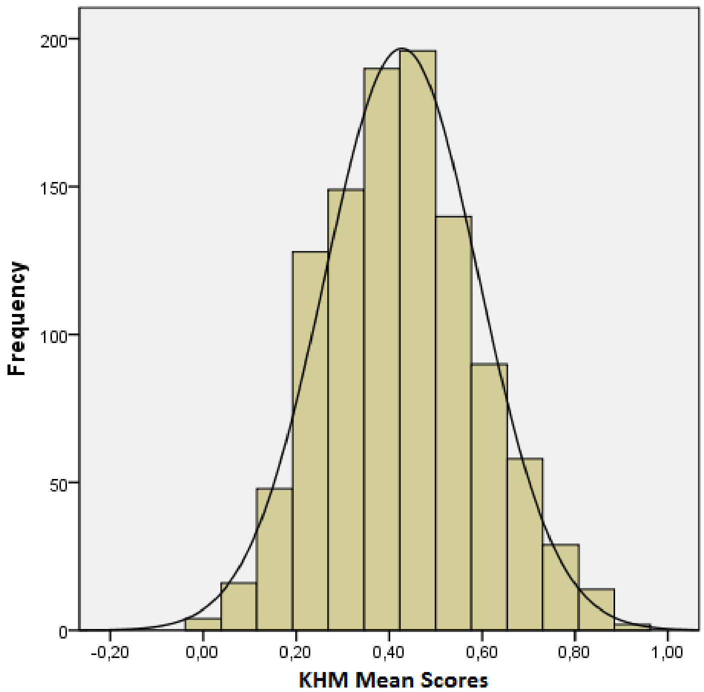



*Figure A.5* Histogram of KHM mean scores of females.

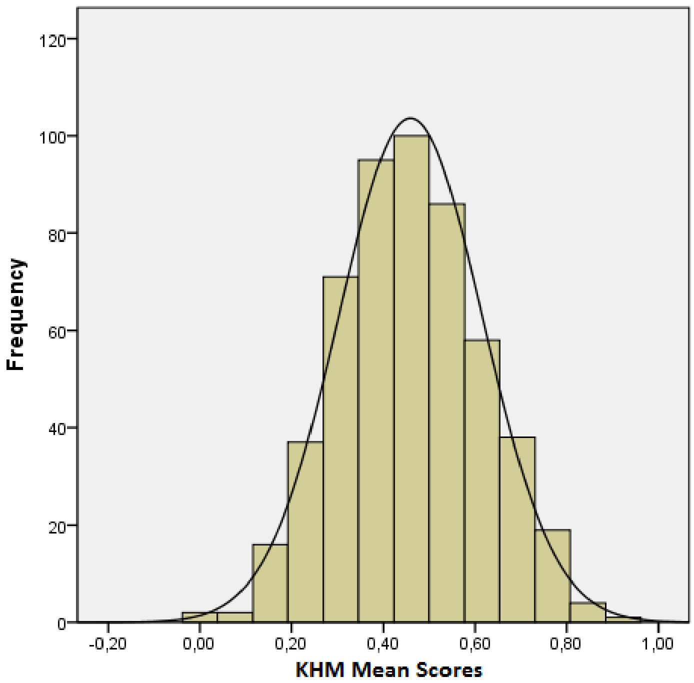



*Figure A.6* Histogram of KHM mean scores of males.

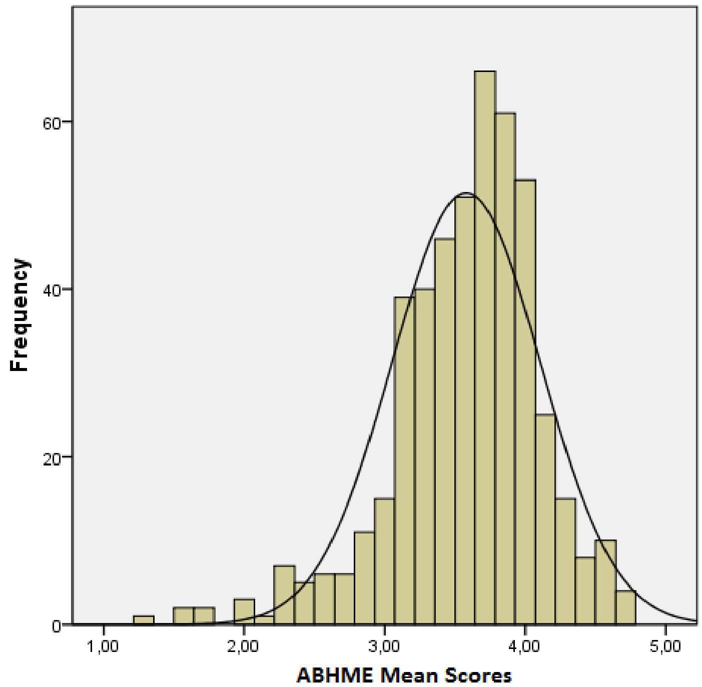



*Figure A.7* Histogram of ABHME mean scores of freshmen.

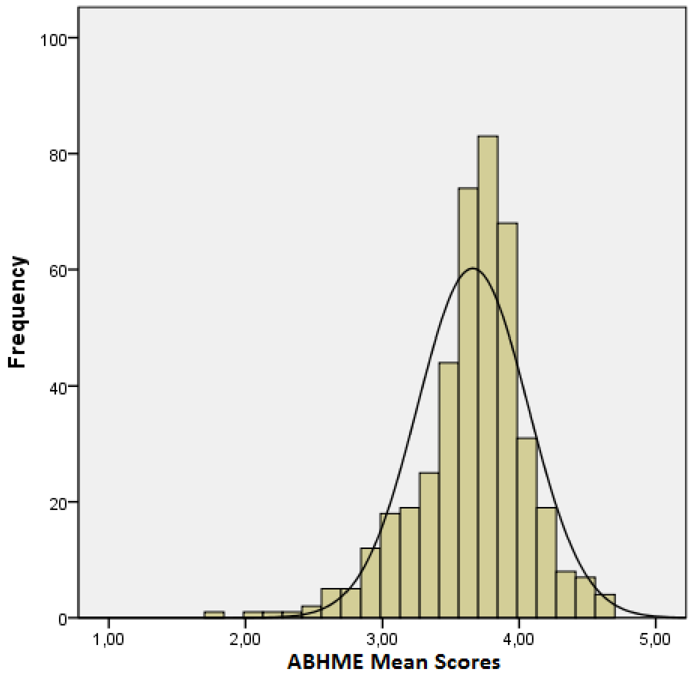



*Figure A.8* Histogram of ABHME mean scores of sophomores.

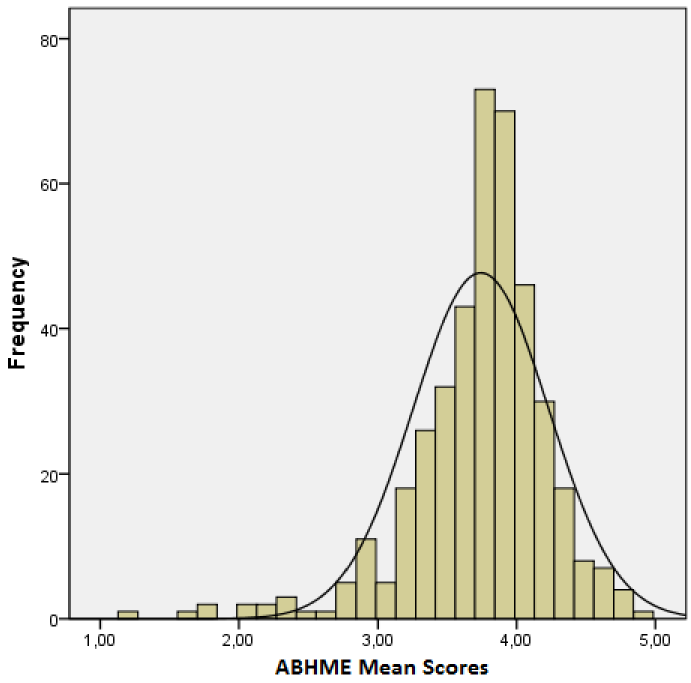



*Figure A.9* Histogram of ABHME mean scores of juniors.

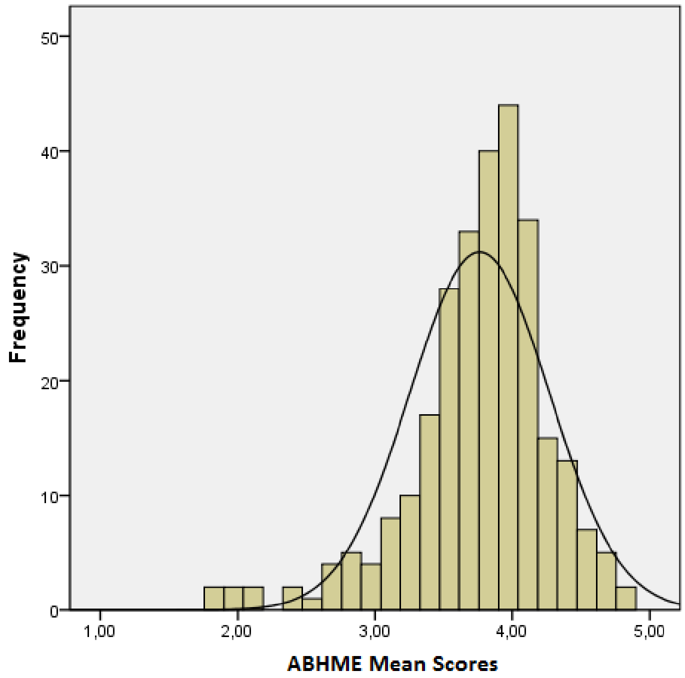



*Figure A.10* Histogram of ABHME mean scores of seniors.

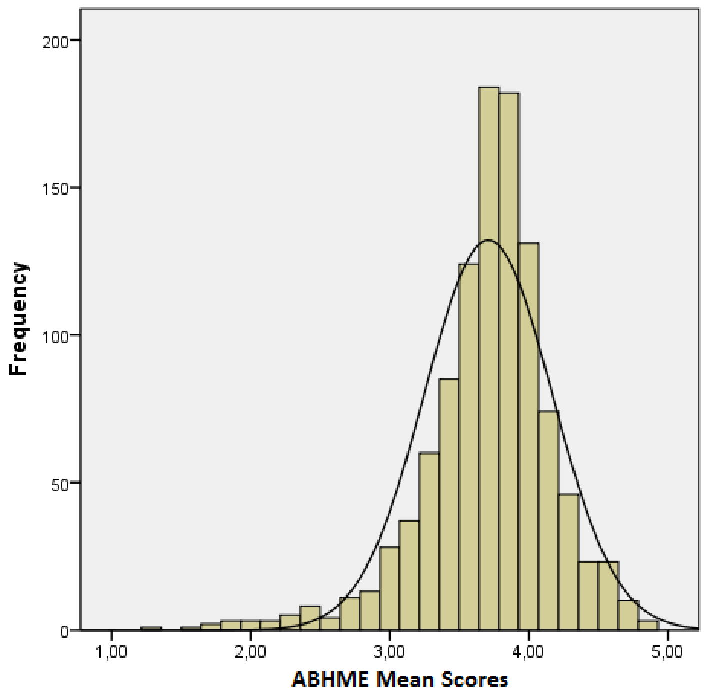



*Figure A.11* Histogram of ABHME mean scores of females.

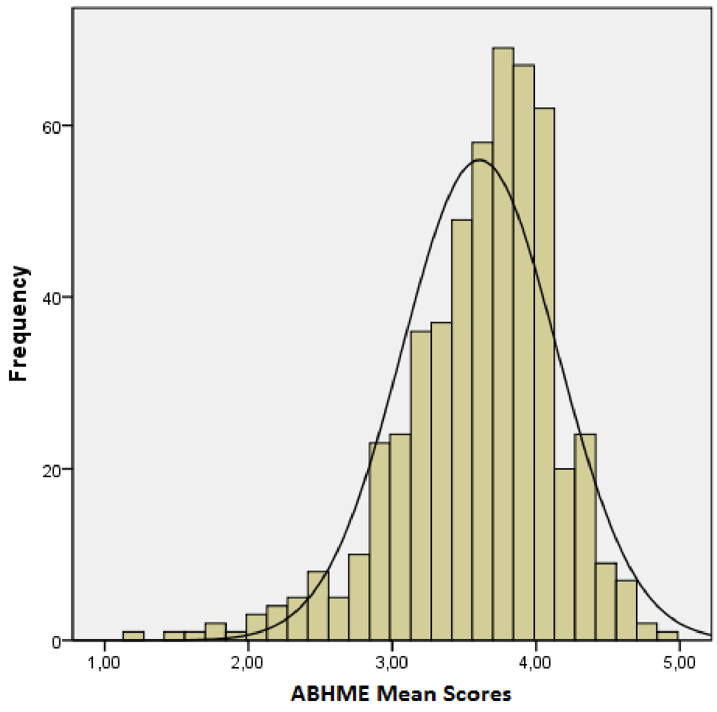



*Figure A.12* Histogram of ABHME mean scores of males.