This study intends developing a valid and reliable instrument in order to determine pre-service mathematics teachers’ attitudes and beliefs towards using history of mathematics in school mathematics courses. The data were collected at the beginning of the fall semester of 2010-2011 academic year from 237 teacher candidates in Turkey via Attitudes and Beliefs towards the Use of History of Mathematics in Mathematics Education (ABHME) Questionnaire developed by the researchers. The reliability coefficient of the ABHME was calculated as .91 and explanatory factor analysis revealed three factors: positive attitudes and beliefs towards the use of history in mathematics education, negative attitudes and beliefs towards the use of history in mathematics education, and self-efficacy beliefs towards the use of history in mathematics education.

INTRODUCTION AND THEORETICAL FRAMEWORK

The attitudes and beliefs of teachers about their profession probably first grow and acquire a shape in their pre-service training programs. Among several elements constituting the education given in undergraduate programs, history of mathematics should take place for better professionally developed future mathematics teachers. In the literature, quantitative measurement instruments for accessing beliefs and attitudes toward using history in mathematics education are limited to a degree. Some of the existing relevant instruments are on some specific issues about the use under consideration. There are also instruments comprising few items which do not seem to be comprehensive enough to see the whole picture. Developing a versatile instrument measuring attitudes and beliefs of pre-service mathematics teachers towards the historical approach is crucial, because they are going to undertake today’s teachers’ educational missions in the future. Thus, this study aims to develop a valid and reliable instrument for investigating elementary mathematics teacher candidates’ attitudes and beliefs towards the use of history of mathematics in mathematics education. Thus, with this purpose research question for this study could be stated as follows:

- What is the underlying factor structure of the Attitudes and Beliefs towards the Use of History of Mathematics in Mathematics Education Questionnaire?

The opinion of that using history in the learning and teaching of mathematics is not new; it has been about since the beginning of the 20th century (Fried, 2001). An historical approach enriches mathematics teachers’ repertoire with its different usages (Mitchell, 1997; Tzanakis & Arcavi, 2000). It supplies meaningful examples of
mathematical algorithms and methods, and offers semantic representations which enable students to see mathematical concepts from unusual perspectives (Furinghetti, 2007). It also supports the preparation of a classroom environment where students discuss the past of mathematics and mathematics as a discipline (Jankvist, 2010). Jankvist (2009) separated the reasons proposed in the literature in favour of using the historical approach into two main categories: seeing history of mathematics as a teaching tool, and seeing it as a goal in itself.

Leder and Forgasz (2002) introduced that the concepts of attitude and belief were defined by different researchers in many times, and there are not common definitions of these. To achieve this study’s goal, the concept of belief was considered in respect of Törner’s study (as cited in Goldin, Rösken, & Törner, 2009). From his perspective, beliefs are strongly related to affective aspects which include attitudes as an element. According to Philipp (2007), individuals’ true-false dichotomies constitute their beliefs. It can be inferred that mathematics teachers’ beliefs about a teaching method amount to their thinking about different components, applications and some other aspects of that method as true or false. In this study, historical approach in mathematics education corresponds to this teaching method. Philipp (2007) also stated that these ideas and dispositions of individuals are clarified by their behaviours. In other words, behaviours are reflections of individuals’ emotions, actions and thoughts called as attitudes. It is possible that mathematics teachers’ attitudes towards an instructional method showed themselves as emotions, feelings, actions, and thoughts about that method. Thompson (1992) expressed that beliefs are sensed less densely, but more cognitively than attitudes. In his opinion, beliefs are structured more strongly than attitudes, so they are less changeable. It can be expected that individuals’ expressions of their beliefs are more direct and certain than their expressions about the attitudes they have. With reference to Leder and Forgasz (2002), these kind of affective matters grab the learning of mathematics as well as cognitive ones. In this sense, the teaching of mathematics is justifiably anticipated to be influenced by affective domain because of that instructors also keep some thoughts, feelings, and emotions to the education which they give. Their beliefs and attitudes towards a teaching method are believed to determine the degree of benefiting from that method, and this will naturally have effects on the quality of instruction that they give.

The inclusion of the history of mathematics in pre-service mathematics teacher training programs has been supported by mathematicians, mathematics educators and mathematics historians (Schubring, 2000). There are many studies on this matter in which pre-service teachers participated. Sullivan (2000) found that a positive change is possible in prospective secondary mathematics teachers’ attitudes towards the integration of history in mathematics education. In the context of Turkey, it was shown that prospective mathematics teachers’ had high positive attitudes towards the historical approach (Oprukçu-Gönülates, 2004). There are also studies regarding historical materials’ use. Fraser and Koop (1978) determined that in-service teachers
liked historical materials, a play and an article, and find them appropriate for mathematics teaching. However, they brought up some concerns about considerable time required, and stated that they would not use such materials in their teaching.

The elementary mathematics curriculum in Turkey draws attention to the importance of using history of mathematics (Ministry of National Education [MNE], 2009). It emphasizes that students must have an idea about the historical evolution of mathematics; its role on many scientific fields, its status and value in the development of human thoughts. It suggests carrying out mathematics projects on several domains of mathematics in which history of mathematics plays a part. In spite of the fact that history of mathematics has such a crucial place in the mathematics education, there are few scientific studies conducted about it. Among these, it is necessary to consider the work of Oprukçu-Gönülateş (2004) as background to this study. She examined pre-service mathematics teachers’ views about the integration of history of mathematics in mathematics courses and determined that they agree on the benefits of the integration for getting high motivation in mathematics classes. They thought that it is more appropriate for motivation than for conceptual development.

**METHOD**

**Participants**

The data of the study were collected via purposive sampling from 237 pre-service elementary mathematics teacher candidates (including 45 freshmen, 52 sophomores, 96 juniors, and 44 seniors) at the beginning of the fall semester of the academic year 2010-2011. The participants, who were 53 males and 184 females, attend elementary mathematics teacher education program in one of the large state universities in Ankara, Turkey.

**Measuring Instrument**

The measuring instrument developed for this study is a questionnaire entitled “Attitudes and Beliefs towards the Use of History of Mathematics in Mathematics Education (ABHME) Questionnaire”. The ABHME consisted of two parts: the first is related to the demographic information such as gender, grade level, etc., and the second part consisted of 35 likert type (where 5 corresponds to “strongly agree” and 1 to “strongly disagree”) items (13 negative and 22 positive). Those items were developed in order to measure pre-service teachers’ attitudes and beliefs towards the use of history in the teaching of mathematics.

In the very beginning of the instrument’s developing process, an item pool including 220 nominee items for the actual questionnaire was formed following a wide review of the literature on the related field, and examining the existing instruments relevant to attitudes and beliefs towards the historical approach in mathematics education (e.g. Clark, 2006; Fraser & Koop, 1978; Oprukçu-Gönülateş, 2004; Percival 1999, 2004; Sullivan, 2000). During this process necessary permissions were taken from the
authors mentioned above. For ensuring the content validity of the instrument, three experts from elementary mathematics education field, and one expert in elementary science education field were consulted. Necessary corrections (like combining and deleting items) were made on the items and number of the items was reduced to 40 after this process. The pilot study was performed with these 40 items which are related to teacher candidates’ attitudes and beliefs towards the usability of the historical approach, its effects on the comprehension of the disciplinary structure of mathematics and the understanding of mathematical concepts, its contributions to their professional development, and their efficacy about using the history of mathematics in their own teaching. The questionnaire items were written by using statements in which the teacher candidates can choose the most appropriate response to their feelings, thoughts, and also possible actions which they would do towards the mentioned sub dimensions (usability of the history in mathematics teaching, the historical approach’s contributions to their professional development etc.) about the history use in mathematics education. The developed instrument’s items which shelter strong expressions are closer to beliefs, and the items that contain less strong expressions are closer to attitudes. These were determined in accordance with Thompson’s (1992) detachment approach among the two concepts as mentioned before. During this test item writing process, the difference between the concepts of attitudes and beliefs were not considered, rather these two very close concepts were dealt in the frame of the affective factors influencing the teaching and learning of mathematics as Leder and Forgasz forwarded (2002). Thus, any item discrimination according to the concepts of attitude and belief was not expected to appear at the beginning of the instrument’s development process. Moreover, separating these two is not a purpose of this study.

For investigating the instrument’s validity and reliability, a software program named PASW Statistics 18 was used. Before the validity and reliability analyses, hot deck imputation was used to fill the missing values in the raw scores. The construct validity of the instrument was gained by factor analysis which intends to reduce great variable (item) sets to smaller component groups (Pallant, 2007). Exploratory factor analysis technique with the principal components factor extraction approach was utilized to clarify the dimensions of the instrument. Varimax rotation was selected to analyse each of the factors appeared, and minimum factor loading for an item to be placed in a component was selected as .3. Before the factor analysis was performed, negative items were recoded.

In Pallant’s (2007) opinion, the number of factors can be limited if researchers think that a particular number is best describing the variables’ interrelationships. Thus, the number of factors was limited to three for this study. After the factor analysis was conducted, the suitability of the data for this factor analysis was controlled by checking the assumptions, which are sample size, factorability of the correlation matrix, linearity, and outliers among cases, as Pallant (2007) offers. The underlying reason for designating the sample size is that it should be at least five times of the
number of the items in the instrument. In other words, five cases are enough for each item in the questionnaire (Tabachnick & Fidell, 2007). In this study, the instrument formed of 40 items was applied to 237 participants, so this sampling is adequate in number. The factorability of the correlation matrix (strength of the relationship among items) was assessed by examining the correlation matrix, Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, and Bartlett’s test of Sphericity. The correlation matrix clarified some correlations of r=.3 or greater among many item (variable) pairs, Bartlett’s test of Sphericity was found significant (Chi-Square $\chi^2=3447.582; p=.000$), and the KMO value was calculated as .871. These are indicators of that the data were appropriate for factor analysis (Tabachnick & Fidell, 2007). It would not be a problem that the linearity assumption was not checked because the sample size is great enough (Pallant, 2007). The data were screened for outliers, but none could be found. After the assumptions were checked and it was understood that there is no problem with conducting the factor analysis, the values concerning the factors were analysed. Moreover, factor loadings of the items were examined with the help of the rotated component matrix in order to make a decision about each component’s items and determine whether any item should be taken out of the instrument or not. The values regarding the factors can be seen in Table 1 below:

Table 1: The values related to the factors (components)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Initial Eigenvalues</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>% of Variance</td>
</tr>
<tr>
<td></td>
<td>Cumulative %</td>
</tr>
<tr>
<td>1</td>
<td>9.893</td>
</tr>
<tr>
<td></td>
<td>24.733</td>
</tr>
<tr>
<td></td>
<td>24.733</td>
</tr>
<tr>
<td>2</td>
<td>2.893</td>
</tr>
<tr>
<td></td>
<td>7.234</td>
</tr>
<tr>
<td></td>
<td>31.967</td>
</tr>
<tr>
<td>3</td>
<td>2.466</td>
</tr>
<tr>
<td></td>
<td>6.166</td>
</tr>
<tr>
<td></td>
<td>38.133</td>
</tr>
</tbody>
</table>

It can be inferred from the table that the three factors explain a total of 38.133 per cent of the variance. Moreover, the three envisaged components before the factor analysis have appeared with 4 items (Factor 3) or more. With respect to Pallant’s view (2007), at least three items loading on each component are sufficient. Furthermore, an item’s maximum factor loading to a component should be at least .1 greater than its factor loading to the other components (Büyüköztürk, 2002). When the maximum factor loadings for each item were examined, it was seen that the maximum factor loading of the item ‘38’ was .155 to the second factor. Because of that an item’s factor loading to a component was selected as at least .3 previously, the item 38 was extricated from the instrument. There are also 5 items whose largest factor loading to a component was not .1 greater than its factor loading to other components. Therefore, they were removed from the instrument, too.
The reliability was ensured by calculating Cronbach Alpha coefficient as .905. This value indicates very good internal consistency reliability for the instrument (George & Mallery, 2001).

After the problematic items were removed from the questionnaire, the same statistical process was conducted for analysing validity and reliability again. It has been seen that the three factors of the finalized questionnaire (35 items composing of 3 factors) explain a total of 39.711 per cent of the variance, Bartlett’s test of Sphericity was found significant again (Chi-Square $\chi^2=2870.341; p=.000$), and the KMO value was calculated as .875 this time. The Cronbach Alpha coefficient is .902, which is a pointer of that the scale’s reliability is too much.

When the contents of the items placed in each component were examined by considering the field of history in mathematics education and some instrument development studies about social sciences (Cantürk-Günhan & Başer, 2007; Turan & Demirel, 2009), a meaningful pattern was established among the components. In respect of this pattern, the factors were defined. The first component is “Positive Attitudes and Beliefs towards the Use of History in Mathematics Education” including positive items of the instrument. The second factor is “Negative Attitudes and Beliefs towards the Use of History in Mathematics Education” corresponding to the negative items. The third and last factor is “Self-efficacy Beliefs towards the Use of History in Mathematics Education” corresponding to items about an individual’s self-efficacy, which is criticism on his/her own proficiency about overcoming tasks specified beforehand in respect of Bandura’s view (as cited in Işıksal, 2005). The items related to attitudes and beliefs were not separated by these underlying factors of the instrument as the researchers expected before. Three sample items from each of these factors can be seen in Table 2 below:

Table 2: Sample items from each of the factors

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning the history of mathematics enriches teacher candidates’ professional repertoire.</td>
<td>Positive Attitudes and Beliefs towards the Use of History in Mathematics Education</td>
</tr>
<tr>
<td>Pre-service teachers must be given courses about how to use the history of mathematics in mathematics education.</td>
<td>Positive Attitudes and Beliefs towards the Use of History in Mathematics Education</td>
</tr>
<tr>
<td>The history of mathematics makes students to notice that mathematics is a universal product.</td>
<td>Positive Attitudes and Beliefs towards the Use of History in Mathematics Education</td>
</tr>
<tr>
<td>It is difficult to integrate history in mathematics education.</td>
<td>Negative Attitudes and Beliefs towards the Use of History in Mathematics Education</td>
</tr>
</tbody>
</table>
Using the history in mathematics education causes students to lose their enthusiasm for mathematics.

Including history in mathematics education hinders mathematics teaching.

I do not have an idea about how to use historical materials.

I do not know how to integrate history in mathematics teaching process.

I do not have enough information about the historical evolutions of the concepts which I will teach in the future.

**RESULTS AND DISCUSSION**

The aim of this study is to build up a valid and reliable instrument measuring pre-service elementary mathematics teachers’ attitudes and beliefs towards the use of history of mathematics in mathematics education. The conducted factor analysis eliminated some of the items (1, 2, 29, 37, and 38) and terminated the number of the items as 35. It also showed that 22 items were gathered under the component “Positive Attitudes and Beliefs towards the Use of History in Mathematics Education”, 9 items were collected under the component “Negative Attitudes and Beliefs towards the Use of History in Mathematics Education”, and 4 items formed “Self-efficacy Beliefs towards the Use of History in Mathematics Education” component. When the possible underlying reasons of the separation of these components are thought, it can be said that a difference existed between in favour of and opposed to the attitudes and beliefs of the teacher candidates towards the said mathematics teaching approach, and the pre-service teachers have a perception about to what degree they are able to use and/or integrate history in mathematics education. Moreover, the instrument was found to have very good reliability (α=.9), which is an indication of high internal consistency among the items. The validity and reliability of it is open to being ensured by other researchers via following the similar procedure mentioned in the method section of this paper. These kinds of attempts should be performed due to having great importance for the field of scientific research.

To bring in such an instrument to the literature will probably inspire the researchers of this field for producing studies regarding the attitudes and beliefs towards the use of
the history of mathematics for the teaching of mathematics either with pre-service elementary or secondary mathematics teachers. If it can be adopted (e.g. by deleting and adding some items, changing some of the items’ words written particularly for teacher candidates) properly, it can also be used with in-service mathematics teachers since the contents of the items are focused on teaching mathematics with its history. In order to advance the investigations of this field, the researchers may use the instrument as an attachment of an experimental study concerned with the use of history in mathematics education in order to reveal potential effects of interventions on the attitudes and beliefs towards the teaching approach in question. Some survey research also can be conducted with the scale in order to see the picture of the attitudes and beliefs towards the historical approach usage of both pre-service and in-service teachers. Moreover, it is believed that these prospective future studies will make a crucial contribution to the research conducted in the field of using history of mathematics in the teaching and learning of mathematics, and take mathematics educators’ attention to this approach some more. Additionally, the results gained by using the instrument by future research projects would have valuable implications for teacher educators in different universities, education policy makers and curriculum developers of different countries in designing curricula for mathematics education in different levels.

REFERENCES


