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Research Article Journal of Pedagogical Research

Does Using History of Mathematics Make Sense? The Views of Teacher Candidates

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Article Info

Article History
Submitted: 2 April 2018
Revised: 11 July 2018
Published: 4 August 2018

Keywords
History of mathematics
Views
Teacher candidates

Abstract

This study aims to determine the opinions of teacher candidates about using history of mathematics (HoM) in the instruction of mathematics. Research data was collected from elementary mathematics education 4th grade students through semi-structured interviews conducted for the purpose of collecting their opinions about using HoM in the instruction of mathematics. The data of this study conducted with qualitative approach was collected from six teacher candidates. The review of semi-structured interviews revealed that teacher candidates believe that using HoM in the instruction of mathematics may be useful for both teaching and learning purposes. Their concerns about using HoM in the instruction of mathematics are another outcome revealed by the study. Regarding the results, it is suggested to teach the courses of elementary mathematics education's undergraduate program that are related to educational content knowledge along with the activities of HoM.

1. Introduction

For many people mathematics is the lessons that make life miserable, exams that spread fear and a nightmare that will be over when the school is completed (Sertöz, 2002). On the contrary, for the others mathematics is understanding the life and admiring it, since the way to love something passes through understanding it. It is thought that the abstract nature of mathematics causes students to develop a phobia against it. On the other hand, from the perspective of the students, mathematics seems as an area disconnected from other disciplines and daily life, which further pushes them away from understanding mathematics. As a result, mathematics becomes an unattractive course and is hated by many students. The nature of mathematics is misunderstood by the students. Mathematics is always considered as something waiting to be discovered in somewhere (Gönülateş, 2004). However, mathematics has always been involved in understanding the events in nature, in the struggle of life, in building simple tools that can answer our daily needs. It is inconceivable to ignore the nature of mathematics in mathematics education. For many student, mathematics is a closed box in the brain of the teacher who decide whether the answer is correct or not. Students try to exactly get the mathematics in the teacher's head rather than creating their own mathematics, which poses a very tough situation for the learning of mathematics (Avital, 1995).

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How to cite: Baki, A. & Gürsoy, K. (2018). Does using history of mathematics make sense? The views of teacher candidates. *Journal of Pedagogical Research, 2*(2), 78-90.

Considering all these challenges in mathematics education, our teachers have great responsibility and duty. Teachers should tear down the walls of students' negative thoughts about mathematics in addition to teaching mathematics. Otherwise, the mathematics to be constructed will be faced every time with a wall that must be overcome. Teachers should be assisted by adding a method to mathematics courses, which may reduce the difficulties and is believed to solve the shortcomings in mathematics education mentioned above. This item, which will lead students to love math, which can introduce the nature of Mathematics, which will show the stages through which mathematics has come to the present day, which will present how it is used in daily life, in short, which will tear down the walls built against mathematics, is the history of mathematics.

HoM will provide a rich repertory to the teachers for showing that mathematics is a human product, for using alternative problems and presenting real life applications of the mathematics (Gönülateş, 2004). Knowing HoM and being able to use this history in mathematics classes through different methods will shed some light to teachers and teacher candidates on designing learning environments for their students by expanding their horizons. Nowadays, many mathematics educators agree that different levels of mathematics learning and teaching can be enriched with HoM. Several groups, such as National Council of Teachers of Mathematics (NCTM) and The Mathematical Association of America (MAA) recommend using HoM in the classrooms for teaching mathematics with meaningful and genuine experiences (Baki & Güven, 2009). In addition, in many studies it was found that the use of HoM in mathematics instruction is very advantageous for both the students, teachers and the knowledge to be learned (Hickman & Kapadia, 1983; Marshall & Rich, 2000; Philippou & Christou, 2002; Liu, 2003; Charalambous, Panaoura, & Philippou, 2009, Uğurel & Morali, 2010).

There are many debates about the necessity of using HoM in the classroom. In his study, Liu (2003) has underlined five of the 15 reasons that Fauvel had outlined in favor of including HoM in mathematics curriculum. These are:

- HoM increases the motivation and helps the development of positive attitudes towards learning Mathematics.
- The challenges encountered in the development of mathematics would help to explain where students of today may have difficulty.
- Historical problems may improve students' mathematical thinking.
- HoM reveals human side of the mathematics.
- HoM guides teacher in teaching.

Gulikers and Blom (2001) have grouped the use of HoM in the instruction of mathematics under three headings, which are conceptual dimension, motivational dimension and multi-cultural dimension. Conceptual dimension is the dimension suggesting that students get a better understanding and meaning of the concepts in the studies conducted using HoM. Motivational dimension is the dimension in which the increase on students' motivation and the development of a positive attitude towards mathematics are discussed. In multi-cultural dimension, the presentation of multi-cultural structure of mathematics to the students along with HoM is discussed. In short, it can be said that HoM is effective for the students in understanding the concepts, having a positive attitude towards mathematics and in shoving them the multi-cultural aspect of mathematics.

The inclusion of HoM in the instruction of mathematics has been studied for a long time. As a result, there are many resources in the literature on this topic. Winicki (2000) has started his study believing that the courses related to HoM, taken during the pre-service education of the teachers, have not been only effective on their formation, they have contributed on their professional development as well. He has set two objectives for his study. First of them was explaining HoM included on teacher education program with a concrete approach, whereas the second was demonstrating its beneficialness on teachers' professional development. In the study conducted with 18 elementary school teachers, three different materials were given to the teachers; they have been classified as reading material, problems and similar problems. The opinions of the teachers

were given at the end of the study. Teachers stated that this aspect of mathematics should also be introduced to the students and it should be a part of mathematics instruction. In addition, the author suggested that the importance of the mathematics in today's culture should be emphasized more and teachers have great responsibility in this task.

Isaacs et al. (2000) have introduced "Cultural Origin of Mathematics" course to elementary mathematics teacher candidates who were at the last year of the pre-service. The objective of this study was to change the opinions of teacher candidates about mathematics. The study was conducted believing that the cultural significance of mathematics, which was underlined by emphasizing social and cultural factors that have affected cultural development of mathematics, would lead to the improvement of teacher candidates' evaluation. In the study, the contents associated with HoM were prepared for teacher candidates under five headings, which were:

- Geometry as a practical science used to solve real problems,
- Geometry as a structural and aesthetic environment in which models, transformations and geometric connections are dominant
- Routine requirements for accurate drawing,
- Measurement as an introduction to irrational numbers,
- Logical explanations in geometry.

Teacher candidates' experience on classroom activities, their reactions towards the tasks and educators, their ideas about the nature of mathematics were recorded into study logs. At the end of the semester, the ideas of the teacher candidates about the education process were collected through a Likert-type questionnaire. At the end of the study, 57% of teacher candidates stated that "Cultural Origin of Mathematics" course has played a role in changing their attitude towards mathematics.

Philippou and Christou (2002) have designed a pre-service program that was based on HoM, in two different universities. This program has been prepared based on the events and paradigms in HoM. The program has been developed such that it would start with the mathematics in Greek and continue with the mathematics in Islam. In one university, the questionnaire was executed twice, before and after the program, whereas in the other university it was applied in three stages. At the end of the study, semi-structured interviews were conducted with ten teacher candidates. As a result of the study it was found that this program that has been prepared for teacher candidates affected the attitude towards mathematics positively. The interviews revealed that HoM has played a significant role in changing teacher candidates' attitude.

Gönülateş (2004) has researched teacher candidates' attitude about using HoM in mathematics instruction, their opinions about different methods of use and their thoughts about the conceptual and motivational benefits of a likely practice. He designed his study as pre-test / execution / post-test. The attitude of teacher candidates was determined through the scale developed for this purpose. At the end of the study the increase on the attitude of the participants were not found to be significant, whereas a significant increase was observed on the number of methods towards using HoM in mathematics instruction.

Tözluyurt (2008) has investigated the effects of using HoM in the teaching and learning of mathematics. Sample of the study consisted of high school students. Activities from HoM, belonging to "numbers" learning domain, have been prepared for the students. The opinions of the students were taken after executing the courses in this way. At the end of the study, it was found that the opinions of all students about the inclusion of HoM into mathematics courses were positive. In addition, students stated that the courses instructed with HoM are easier and more apprehensible. At the end of the study, the researcher pointed that teachers have not sufficient information about HoM and directed their students to different sources. At this point, he suggested that teachers should be trained about HoM and using it in mathematics instruction before starting their profession.

Charalambous, Panaoura and Philippou (2009) have measured the effectiveness of a university preparation program based on HoM, analyzing teachers' epistemological beliefs and attitude

towards mathematics. They found that the teachers who have participated in the study had used to have very strict ideas about mathematics, but their ideas were changed after the pre-service training that they have get. At the end of the study, researchers emphasized that this pre-service training based on HoM should be given to teacher candidates as well. They recommended to give this training during university, believing that it would be useful to enlarge teacher candidates' horizons in mathematics instruction and it would affect their attitude towards mathematics.

The review of the literature showed that there are many resources about the inclusion of HoM into mathematics instruction. The review revealed that the studies presenting theoretical information about using HoM in mathematics instruction emerged first, followed by the studies whose sample was formed by the students. As time goes on, studies featuring how to include HoM into the lessons of mathematics through different methods emerged. As we approach to today, studies conducted with teacher candidates leaped out. It is interesting to see that most of the studies conducted abroad work on the opinions of teacher candidates about using HoM in mathematics instruction, whereas this type of studies is very rare among local ones.

1.1. Research Problem

The topic of using HoM for improving the quality of mathematics education occupies a large place in the literature. In many researches, the materials developed for this purpose were applied within the classroom and their effects on students' cognitive and affective learning were investigated (Karakuş, 2007; Tözluyurt, 2008; Bütüner, 2008; Charalambous et al. 2009). These studies revealed that using HoM in mathematics lessons has many advantages and it is recommended to be used by the teachers. Although many educators recommend to use HoM in mathematics courses, it is obvious that teachers and teacher candidates has shortcomings in terms of experience on this subject. In order to prevent to be faced with the same issue in the following years, it is crucial to train and inform teacher candidates who are the teachers of the future. On the other hand, there is no available course in the education faculties concerning the use of HoM in mathematics instruction. It is important to determine the content and method of such a course through need analysis, before introducing. Very few studies were conducted about the thoughts of the teachers and teacher candidates about this subject and their needs. Considering this point, the research problem was set as "What are the opinions of teacher candidates about using history of mathematics in mathematics instruction?".

1.2. The Aim

Recent studies underline that teachers should be informed about HoM during pre-service process. The reason of this necessity is the training of the teachers on duties impedes education-training activities and leads to a loss of time. In order to prevent this loss of time, it was suggested to inform teachers during the pre-service period. Despite these recommendations, in our country, only one study was found regarding the use of HoM in mathematics instruction involving teacher candidates. As mentioned before, the use of HoM in mathematics instruction is recommended by many researchers and major institutions of mathematics education. However, the literature review showed that there are very few studies featuring HoM. This study is quite significant in terms of fulfilling the gap of our own literature. Moreover, as mentioned before, this study is important for determining the content and method of a non-existent course through need analysis.

As mentioned before, many educators and researchers recommend to use HoM in mathematics instruction. The opinions of the teachers, who are supposed to use these methods, should be investigated at university level. In this regard, determining teacher candidates' thoughts about using HoM in mathematics instruction is the main purpose of the study.

2. Method

2.1. Research Design

The study was designed as a qualitative survey, in which semi-structured interviews were used as the data collection tool. First of all, the questions of the interview that will be conducted with teacher candidates have been identified. The essential questions to be asked have been decided by consulting expert opinion. Pilot interviews were conducted with two teacher candidates in order to see the duration of the interview, to check the understandability of the questions and to determine sub-questions. After this, semi-structured interviews were conducted with six different teacher candidates.

2.2. Participants

Six students, who were randomly selected among the 4th grade students taking elective "HoM" course in the undergraduate program at a public university of Turkey have participated in this study. Teacher candidates have seen the change and evolution of mathematics across the history and performed some activities about how to use HoM in mathematics courses within the scope of the elective "HoM" course.

2.3. Data Collection Tools and Data Collection

Semi-structured interview method was employed to deeply examine the opinions of teacher candidates about using HoM in mathematics instruction. Pilot interviews of the survey were conducted with two teacher candidates. After the pilot interviews, the questions to be asked to the teacher candidates were set as below:

- What is the contribution of "HoM" course to you?
- Do you consider using HoM when you start to work as a teacher?
- According to you, what will be the contribution of the courses instructed with HoM?
- What will be the effect of using HoM in mathematics course on the learning activities of the learners?

Additional sub-questions were also posed depending on the answers given during the interview. Semi-structured interviews were conducted with six randomly-chosen teacher candidates in the light of these questions. The duration of the interview was set as 15-20 minutes and the conversation with the students took place in the working room. The absence of any other person, except the person who participated in the interview and the one who conducted it, has led to the creation of a comfortable dialog. Conducting all interviews took one day. Before the interview, the reasons of recording were explained to the student and the interview was started upon the consent of the interviewee. Following the completion of the interviews, the conversations were listened again and put in writing for the analysis.

2.4. Data Analysis

During the analysis of the questions, the answers of teacher candidates were first analyzed on question basis, then they were tried to be analyzed as a whole. Teacher candidates' answers were coded and the themes were formed based on these codes. The codes and their frequencies are presented in figures. The names of the participants were kept confidential, interviews were analyzed by coding their names respectively as TC1, TC2, …, TC6. While giving examples for the findings, the dialogue of one teacher candidates was quoted instead of giving the dialogues of all teacher candidates.

3. Findings

In this section, the findings regarding the research problem are shown for each interview question. First of all, teacher candidates' answers will be given in a figure, then the dialogue with one teacher candidate will take place to constitute an example.

In the first question of the interview, the researcher has posed "What is the contribution of HoM course to you?" question to teacher candidates. Their answers are summarized in Figure 1.

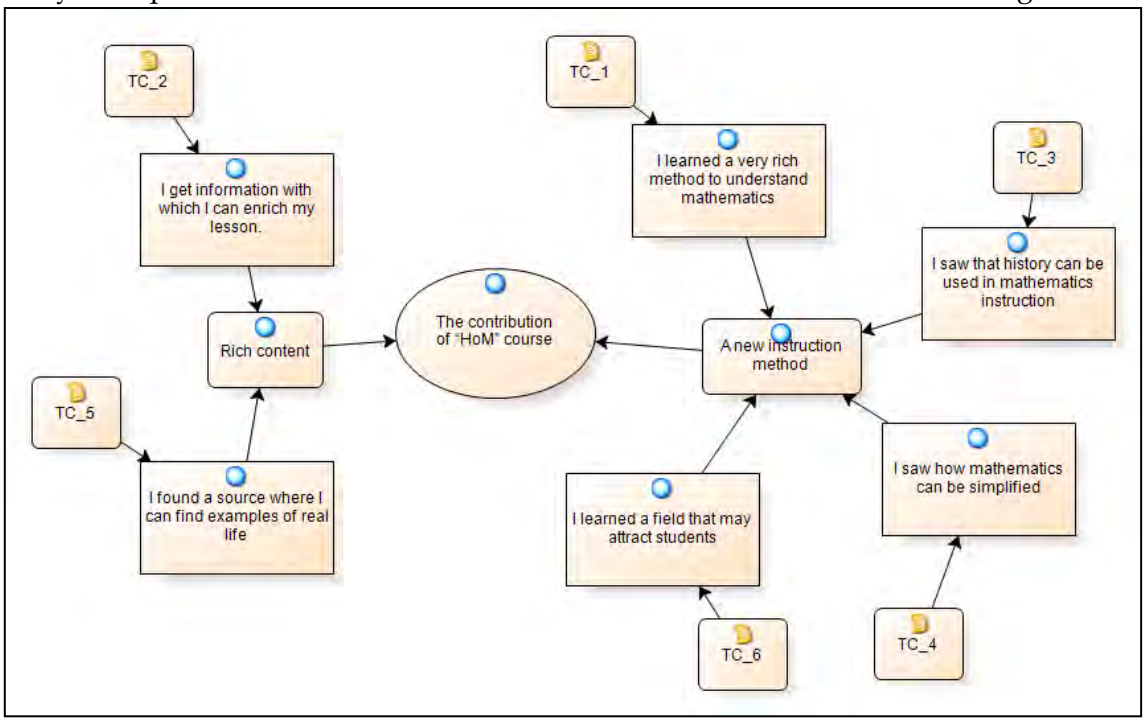

Figure 1. The contribution of "HoM" course

The review of the figure shows that the answers given by teacher candidates can be considered in two different categories. One of them was coded as a new instruction method, whereas the other was coded as rich content. The dialogue between the teacher candidate coded as TC_5 and the researcher is given below.

Res. : What is the contribution of "HoM" course to you?
TC_5 : Before starting this semester, I was thinking how I would pass this course because there is history on the course's name. I'm not good in history. But, when the course started I saw that it is not like history. My thoughts about the course slowly began to change. We started to work on the mathematicians in the history, we started to learn how to use them in lessons. Then I started to enjoy the lessons thoroughly.
Res. : What did it added to your understanding of teaching, we did courses during a semester, we had discussions there, what was the enduring effects of them on you?
TC_5 : The most touching effect on me is being full of examples from daily life. We have prepared activities in certain courses.
Res. : Which courses?
TC_5 : Special teaching methods, material development. We were trying to give examples from daily life while preparing activities within these courses. We were trying to give example from daily life that students may encounter. We had extreme difficulties in making this. After getting HoM course I can say that there are so many examples associated with real life.

From the analysis of the interview conducted with TC_5, it can be said that teacher candidate stated that HoM course provided him a new resource where he can find examples from daily life.

In the second question of the interview, the researcher has posed "Do you consider using HoM when you start to work as a teacher?" question to the teacher candidates. Their answers are summarized in the figure below.

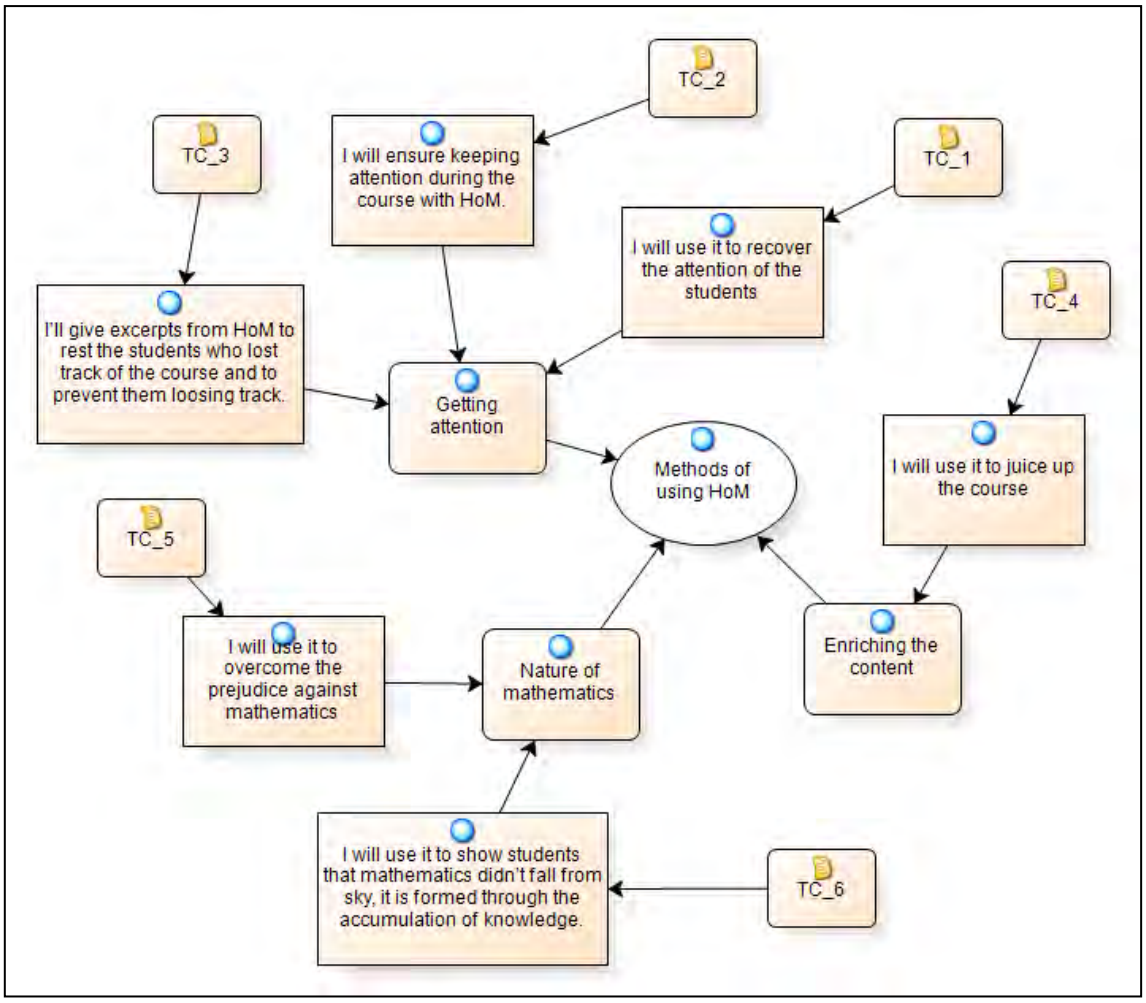

Figure 2. The methods of using HoM

The review of the figure shows that the answers given by teacher candidates can be grouped in three different categories. One of them is getting attention, the other is overcoming the prejudice, whereas the other is enriching the content. The dialogue between the teacher candidate coded as TC_3 and the researcher is given below.

Res. : Do you consider using HoM in your teaching life?
TC_3 : Yes sir, I think.
Res. : How do you consider to use it?
TC_3 : May I explain it with an example?
Res. : Sure.
TC_3 : Let's say I teach my lesson, and I notice that the attention of the class towards the course is reduced and what I instruct begins to seem meaningless to them. In this case I will stop teaching the lesson and I will start to talk about something from HoM. I will use there.
Res. : Would you tell anything to your students?
TC_3 : If the topic is suitable, I will talk about something relevant. It will allow them to rest and talk about something about the topic. In addition to giving a break, I believe that HoM is a perfect tool for recovering their attention.

As can be understood from the interview conducted with TC_3, teacher candidate considers using HoM for resting the students and ensuring that they don't fall away from the course.

In the third question of the interview, the researcher has posed "According to you, what will be the contribution of the courses instructed with HoM?" question to the teacher candidates. Their answers given by teacher candidates are grouped and given in Figure 3.

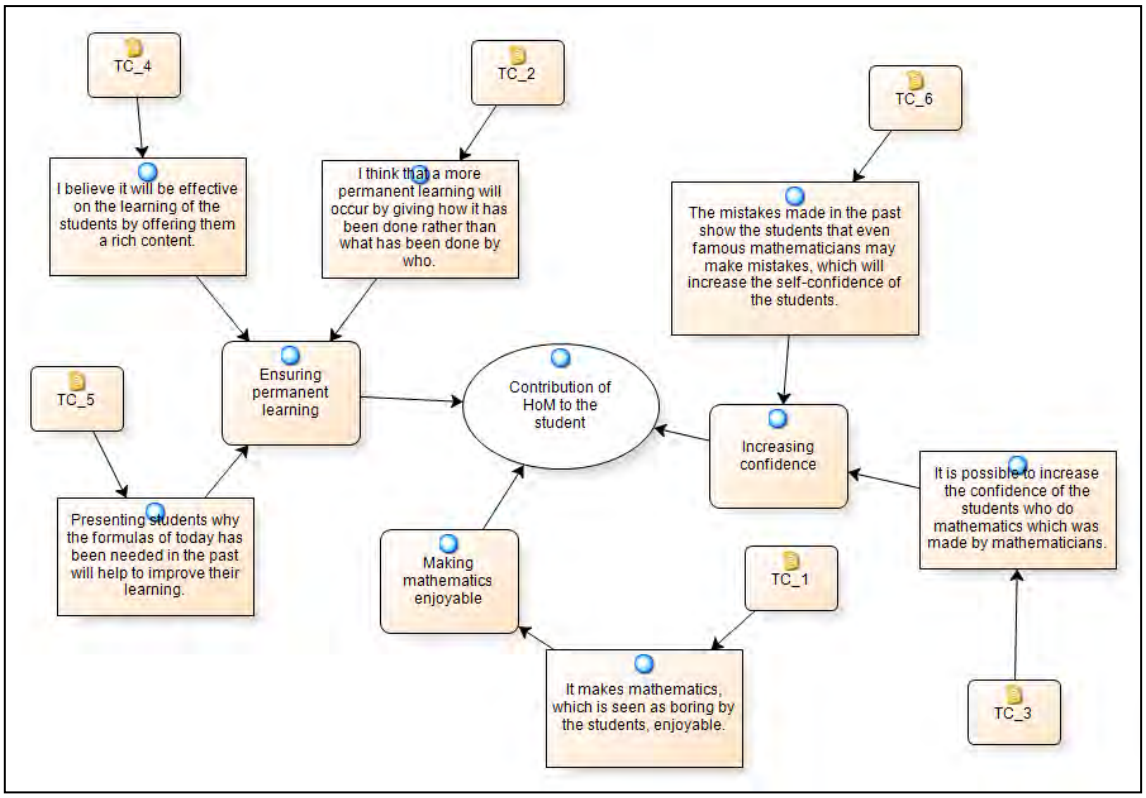

Figure 3. The contribution of HoM to the student

The review of the figure shows that the answers given by teacher candidates can be considered in three different categories. Teacher candidates believe that if they use HoM during the lessons, mathematics, which is seen as a boring course, may get enjoyable in the eyes of the students; in addition, it may increase self-confidence of the students and make their learning more permanent. The answers given by the teacher candidate coded as TC_1 are given below.

Res. : According to you, what will be the contribution of the courses instructed with HoM?

TC_1 : Mathematics is seen as a boring course by the students. With HoM, the courses will be enjoyable for them. It is likely that they will be able to look at mathematics from a different perspective.

According to the review of the interview conducted with TC_1, it can be said that teacher candidate believes that the main contribution of HoM to the student is making mathematics course more enjoyable.

In the fourth question of the interview, the researcher has posed "What will be the effect of using HoM in mathematics course on the learning activities of the learners?" question to the teacher candidates. Their answers and grouping are shown in Figure 4.

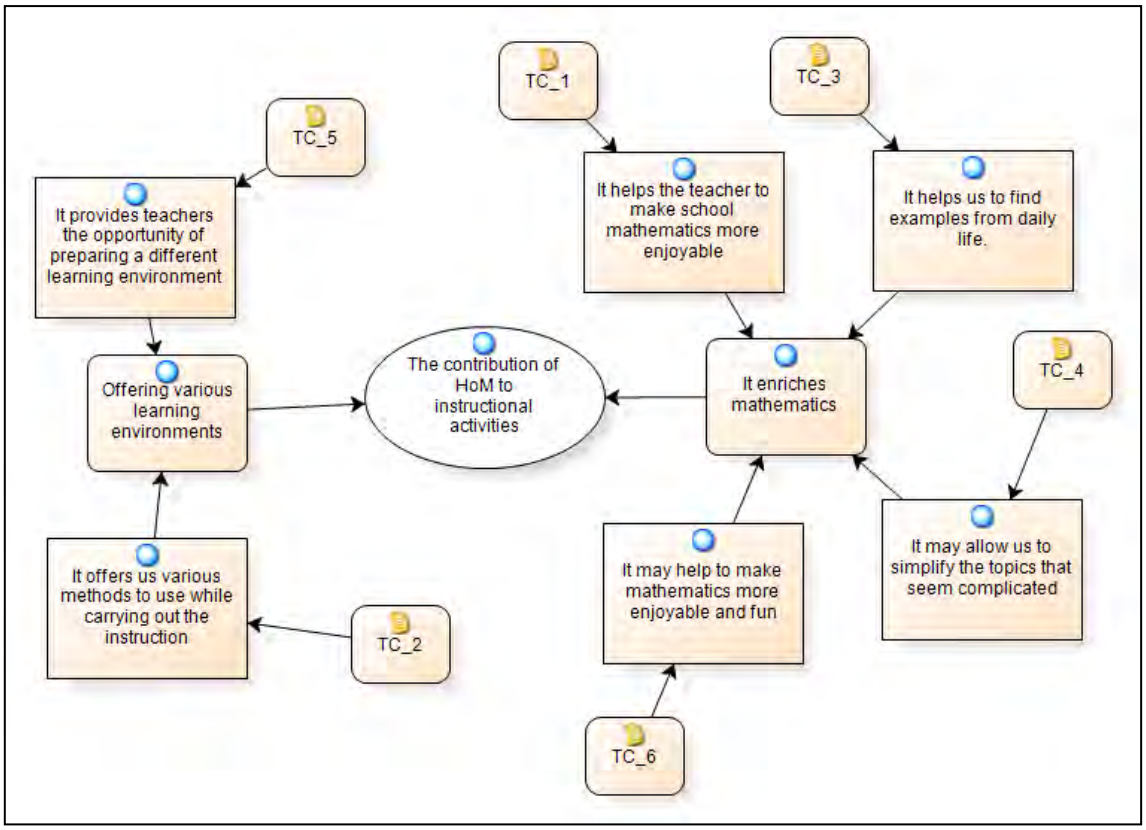

Figure 4. The contribution of HoM to instructional activities

The review of the figure shows that the answers given by teacher candidates can be considered in two different categories. As a result of the interviews, it was found that teacher candidates believe that HoM will assist them by enriching mathematics and by providing a different method to them. The dialogue between the teacher candidate coded as TC_4 and the researcher is given below.

Res. : What will be the effect of using HoM in mathematics course on the learning activities of the learners?

TC_4 : I want to give an example from myself. We had a task during HoM course about finite sums. There was a paradox at the beginning. I really learned a lot from this task. In the past I've heard the story of the tortoise and the rabbit but I couldn't understand why the rabbit cannot pass the tortoise. At the end of the course, I understood the situation regarding the paradox. Afterwards, I understood the concepts of finite sums and infinite sums, which seemed to be irrelevant. Actually, my thoughts about using HoM in the course have changed after this lesson.

Res. : Can you detail a bit the change that you have experienced?

TC_4 : At the beginning of the semester, I didn't believe you while you were explaining its benefits. So, quite frankly, I was seeing it as an unnecessary course. In each lesson I was thinking I could maybe use one day, but after this lesson I believed that it can actually work. It explained a topic that I have not understand before in a very simple way, it associated it with a topic that is difficult to comprehend and explained this topic very well.

Res. : So, you say that a change occurred. My question is what will be the benefit of it for the teacher?

TC_4 : What changed my mind is handling a difficult topic in a simple and understandable way. I'm also planning to present the topics that pose difficulty for the students with the examples from HoM. Because it allows us to simplify the topics that seem complicated.

In the interview conducted with TC_4, teacher candidate stated that HoM may be beneficial for the teachers in simplifying the topics that seem complicated.

Regarding the overall evaluation of the interviews conducted with teacher candidates; they believe that HoM course taught them a new instruction method and allowed them to be aware of a rich content. Another finding obtained from the interviews is teacher candidates consider using HoM. Teacher candidates stated that they will use HoM for getting the attention of the students, enriching the content and teaching the nature of mathematics. Besides, according to the outcomes of the interviews teacher candidates believe that using HoM in mathematics instruction will make mathematics enjoyable for the students, allow permanent learning and improve self-confidence of the students. Another finding obtained from the interviews is teacher candidates believe that using HoM will help them in enriching mathematics and in creating different learning environments. The overall picture based on all the answers collected from teacher candidates is given in the figure below.

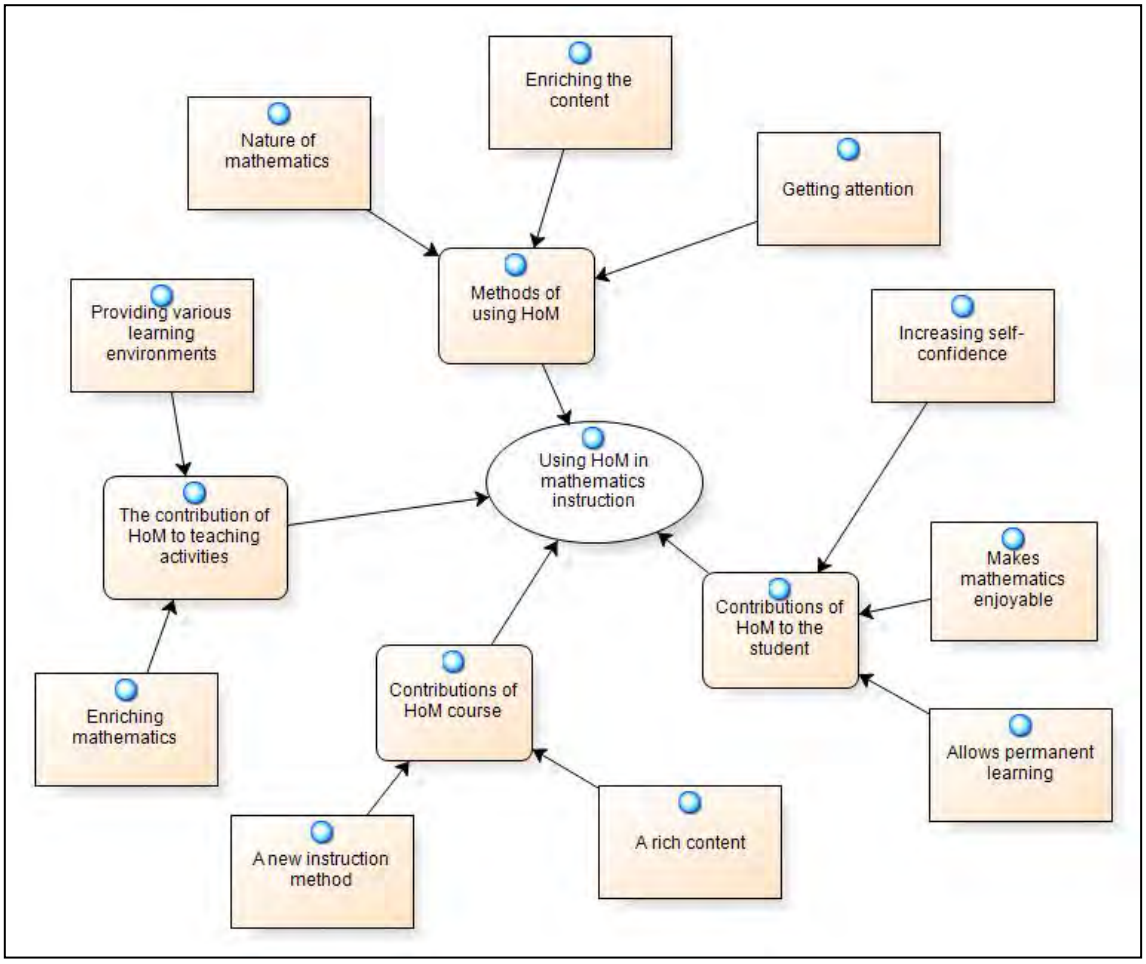

Figure 5. Overall picture regarding the use of HoM in mathematics instruction

Another finding revealed with the interview questions posed to the teacher candidates is the concerns that teacher candidates felt about using HoM in mathematics instruction. One of these concerns is the timing. In the interviews, teacher candidates stated that they don't expect to have enough time for using HoM in mathematics instruction, they believe that they will encounter problems in meeting the time schedule. In addition, they told that there is not enough source in Turkish and even when they do research, they can only find resources in English.

4. Discussion

In this study, interviews were conducted with teacher candidates to determine their thoughts about using HoM in mathematics instruction. In the eyes of teacher candidates, HoM is a course allowing permanent and enjoyable learning of the students, covering many daily life examples for teachers and providing a resource that will enrich lessons. Teacher candidates see HoM course as a

course where a new method is taught. In addition, they believe that students' learnings get more permanent in the lessons instructed with HoM. What is laying behind the formation of this belief is thought to be the experiences that they have lived in HoM course. Moreover, teacher candidates state that HoM has a very rich content in terms of providing examples from daily life. During the course it was explained that mathematics had born from daily needs, which may have an effect on the development of this ides. In other words, it can be said that the execution of the activities about the mathematics arising from daily needs during the first weeks of HoM course may be a significant factor in the formation of this idea. Isaacs, Ram and Richard (2000) suggested that teacher candidates had enjoyed to work with HoM. In addition, another fact mentioned by teacher candidates was that the course of mathematics got rid of the boring course format. The answers given by our teacher candidates during the interviews are in line with the answers given by the teacher candidates in Isaacs, Ram and Richard's (2000) study. Besides, we can see the statement "it makes mathematics enjoyable, which is seen as boring by the students" mentioned by the teacher candidates during the interviews in the form of "the course of mathematics gets rid of a boring course format" in the study of Isaacs, Ram and Richard (2000). The reason of seeing similar findings in both studies may be the exhibition of the fun part of mathematics to teacher candidates through HoM. One of the questions included in the interviews with teacher candidates was "What will be the contribution of using HoM in mathematics course to the learners?". The analysis of the answer given by teacher candidates revealed that they show similarities with the answers of the teachers in Winicki's (2000) study. According to the opinion of teacher candidates and the teachers of Winicki, using HoM in mathematics instruction would show the enjoyable part of the mathematics to students. The reason of obtaining such a finding in both studies may be both teacher candidates and teachers have learned how to include HoM into the mathematics lessons through the materials prepared for them.

The outcome revealed as a result of the semi-structured interviews conducted with teacher candidates in HoM course, which pointed the lack of sufficient resources, has also been mentioned in the post graduate study of Tözluyurt (2008). The students in Tözluyurt's study stated that they could not get answers to the questions that they have asked to their teachers and they were directed to different resources. Similarly, there were complaints about the lack of sufficient resources in the statements of teacher candidates. On the other hand, they have stated that they believe that they have not get enough course about using HoM in mathematics instruction.

5. Conclusion and Suggestions

From the perspective of teacher candidates, HoM course is seen as a course in which a new instruction method is shown and the examples associated with this method are provided. In addition, teacher candidates prefer to discuss the mathematics found in the works of famous mathematicians rather than the mathematicians themselves. As another outcome of the study, it was found that teacher candidates will use HoM in three ways; getting attention, enriching the content and the nature of mathematics. Teacher candidates focused on getting the attention of the students under the heading of getting attention, whereas they mentioned juicing up mathematics course under the heading of enriching the content. Regarding the nature of mathematics, the third heading, teacher candidates stated that it would help to break the prejudice against mathematics and to show that mathematics is formed through knowledge accumulation. Considering all these facts, it can be concluded that teacher candidates consider using HoM. Besides this, teacher candidates have listed the benefits of the courses instructed with HoM to the students as ensuring permanent learning, making mathematics enjoyable and increasing self-confidence. Therefore, it can be concluded that teacher candidates believe that using HoM in mathematics instruction will have positive effect on the students as well. Teacher candidates' belief that HoM will enrich the mathematics and will provide different learning environments is another outcome of the study.

Besides all these positive beliefs and attitudes, another fact discovered in the study is that teacher candidates have some concerns about using HoM in mathematics instruction, they are associated with the lack of resources and time.

In this study, the opinions of teacher candidates about using HoM in mathematics instruction were investigated. The following suggestions can be submitted based on the outcomes of the study.

- The attitudes of teacher candidates will develop positively if HoM course instructed at the university is taught along with the examples about how to use HoM in mathematics instruction.
- Studying the mathematical structure of the works instead of talking about the life and actions of famous mathematicians has significant impact on the attitude of teacher candidates. Therefore, the focus of the course should be how it was done rather than what it was done.
- Considering that this study will set an example for future researches, some suggestions were submitted for the researchers.
- The cognitive and affective levels of the students may be analyzed through the activities developed during this study or by creating different activities.
- In order to show the change on the belief and attitude of teacher candidates in a more detailed way, surveys should be run with teacher candidate and clinical interviews should be conducted with them during the process.
- In-service trainings should be designed for training teachers who are already graduated from education faculties and who are in active duty, about using HoM in mathematics instruction, covering the necessity and significance of using HoM in mathematics instruction and giving some examples. Besides this, teachers may be asked to develop course plans where HoM is used in mathematics instruction.

Acknowledgements

This article is based on a master's thesis completed by the second author under the supervision of the first author.

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