ISSN: 2148-9955

International Journal of Research in Education and Science (IJRES)

www.ijres.net

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To cite this article:

Kul, U. & Celik, S. (2017). Exploration of pre-service teachers' beliefs in relation to mathematics teaching activities in classroom-based setting. *International Journal of Research in Education and Science (IJRES)*, *3*(1), 245-257.

IJRES International Journal of Research in Education and Science
Volume 3, Issue 1, Winter 2017 ISSN: 2148-9955

Exploration of Pre-service Teachers' Beliefs in relation to Mathematics Teaching Activities in Classroom-based Setting

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Article Info

Article History

Received:
28 October 2016

Accepted:
30 December 2016

Keywords

Mathematical beliefs
School-based practicum
Pre-service teachers
Teaching practice

Abstract

This paper has been conducted to determine future teachers' mathematical beliefs and to explore the relationship between their mathematical beliefs and initial teaching practice in a classroom setting, in terms of how they design the content of teaching activities, they employed the style of teaching in mathematics, and they engaged with pupils. A collective case study approach was used for this study so as to concentrate on a belief and belief in action association with numerous examples. Pre-service teachers were observed using a variety of procedures to reveal qualitative data about their teaching practice during the school-based practicum, and were then requested to complete six open-ended questions form concerning mathematical beliefs. The analysis of data revealed considerable coherence among pre-service teachers' beliefs in relation to teaching and learning of mathematics and consistent associations between their beliefs and their teaching practices in a classroom-based setting. Although pre-service teacher' accounts emphasized the use of contemporary approaches in mathematics teaching to enhance and extend students' learning of mathematics but they felt not enough confident to integrate these ideas into teaching mathematics effectively. In addition, some teachers who held a learner-based mathematical beliefs but were teaching mathematics in a classroom with traditional sense.

Introduction

There has been considerable amount of research on cognitive and affective domains that teachers have (their knowledge, attitude, affect and beliefs…etc.) and also on exploration of the relation of these domains with teaching activities in classroom based setting because they have important influences on teachers' learning, teaching practices and professional development (Aguirre & Speer, 2000; Handal, 2003; Golafshani, 2005; Philipp, 2007; Richardson, 1996; Skott, 2001; Speer, 2005; Thompson, 1992). Among these domains, especially the construct of beliefs have important effect on teachers' roles during learning and teaching processes and on the ways they design classroom activities, and also on their decisions for what to teach and how to teach (Cross, 2009; Liljedahl, 2010; Nespor, 1987; Thompson, 1992). Rather than just implementer of the curriculum, teachers are also decision makers for what to learn and what to teach during lessons since they have important role in organizing the classroom as the effective learning environment (Ernest, 1989). Within this scope, while teachers are organizing creative, interactive and multidimensional classrooms, they are under the impact of their own beliefs (Wilson & Cooney, 2002). These beliefs are formed by their past experiences. In fact, beliefs are originated from teachers' personal experiences as students and later beliefs are shaped by their experiences as undergraduate students during teacher education (Lortie, 1975). When pre-service teachers start getting their university education, their beliefs about mathematics have already been shaped in their former education as a result of their teachers' own beliefs and teaching practices in classroom. These beliefs restrict pre-service teachers' experiences in university and decrease the effectiveness of the teacher education program (Nespor, 1987). However, one of the most important aims of the teacher education programs is to enable pre-service teachers to develop particular beliefs that are necessary to complete the target education. In order to increase the effectiveness of teaching and learning, teachers who know the relationship between teaching and learning should question their own beliefs, analyse whether their teaching is in accordance with these beliefs and they should also know through which belief they are directing their students. For pre-service teachers' being effective in developing their classroom activities and having efficient teaching strategies professional development becomes very crucial.

In the last decade, constructivist philosophy has gained importance for Turkish educational system and as a result of this, mathematics curriculum has been renewed and revised to be more student oriented. The primary goal of this new student-oriented curriculum is to enable active participation of the students and as a result provide them

with opportunities for constructing their own knowledge and developing their mathematical thinking skills (Baki, 2008). Contrary to traditional approach, with the help of constructivism, personal characteristics, intelligences and individual differences are taken into consideration. With this approach the roles of students and teachers are changed. Rather than being only first-hand source of information; teachers become guides for students to construct their own knowledge. On the other hand, students begin to get knowledge by themselves and form it again according to their own characteristics instead of just waiting for somebody to give it. Teaching approaches that are inspired by the principles of constructivism are included to the aims of teacher education programs especially after education faculties have been reformed.

Moreover, during this process of reformation, teachers' role in using teaching strategies that are accordant with innovative perspective gains importance (Wilson & Cooney, 2002). According to Handal and Harrington (2003), the pace of the reforms in education and the success of these reforms depend on teachers' common beliefs because while teachers are creating the learning environment, they act according to their own beliefs. In his study, Ambrose (2004) states that although teacher education programs partially affect teachers' beliefs, they cannot change these beliefs completely. Before applying the changes in mathematics education, teachers should be informed about the benefits underlying this innovation and should believe in the necessity of the changes. Therefore, in our country, for the implementation of mathematics teaching that is congruent with constructivist philosophy, it is necessary for teachers to have beliefs that help them to use this new teaching approach. If teachers review their beliefs while evaluating their teachings, they can find out the reason behind their ineffective teaching. Teachers' knowledge is not the only determinant of their different teaching practices in classroom. These different practices can be explained by analysing the beliefs of the teachers (Pajares, 1992). On the other hand, Kane, Sandretto and Heath (2002) emphasised that future teachers' beliefs may assist to hinder their knowledge and in turn their pedagogical content knowledge. Therefore, this study is important as it provides an understanding and evaluation of teachers' mathematics-related beliefs. By this way, teachers' beliefs about teaching approaches and also the uses of teacher education programs can be revealed.

Due to its key role in mathematics teaching and learning, mathematical-related beliefs gain importance day by day and attract attention of the researchers who explore the field of mathematics teaching (Haser, 2006; Kul, 2013; Phillip, 2007; Stipek, Givvin, Salmon & MacGyvers, 2001; Swan & Swain, 2010). Studies in the field of mathematics education investigate different types of beliefs or they investigate the beliefs by considering different groups (students, pre-service teachers and teachers) or different approaches. Research conducted before show us that there is a relationship between teachers' mathematical beliefs and their teaching practices. Although there are several factors that affect teaching practices of the teachers, Speer (2005) argues that there is a strong relation between teachers' beliefs and the approaches they use during their teaching practices in the classrooms. It can be said that studying pre-service teachers' beliefs about subject matter that reflect their priorities for teaching practice in mathematics and is a significant part of understanding their actions in their future classroom. The intention of this study was to understand teachers' mathematical beliefs and their pedagogical practices. The above aims are reflected in the following research questions. For this reason, this particular study aimed at better understanding of what type of pedagogical beliefs pre-service teachers hold and how they enact these beliefs into their teaching practice.

Literature Review

In recent years, studies that focus on teachers gain importance because of their important position in the process of teaching and learning. While various studies researchers have examined the beliefs informing teachers' pedagogical decisions in relation to mathematics teaching in classrooms descriptively, others have examined the connection between teachers' mathematical beliefs and their teaching practices (Cross, 2009; Ernest, 1989; Liljedahl, 2010; Wilson & Cooney, 2002). In this regard, the current study explores the relationship between pedagogical beliefs concerning teaching activities of mathematics and initial teaching practice in real classroom setting. The subsequent literature review is formed by teachers' mathematical beliefs and its relationship with teaching practices.

Teachers' Mathematical Beliefs

Beliefs have some common characteristics of cognitive and affective domains that individuals possess (Pehkonen, 2004). Although the term of 'belief' is very popular among educational researches, there is no common definition of it that is accepted by researchers. For example, according to Cross (2009) "beliefs are conscious or unconscious opinions and views of the individual about himself, about the world or about his place in the world. These

opinions develop during the individual's joining in different social groups and also they are considered as correct by the individual" (p.326). Similarly, Sigel (1985) defines beliefs as mental constructions of experience. Thus, according to the common view of the researchers, beliefs are structures that individuals accept as true and from which their behaviours get affected. Wilson and Cooney (2002) expressed the idea that knowing is a stronger condition than believing. Each teacher has different kinds of beliefs such as beliefs about students' learning, curriculum, textbooks, self-efficacy and pedagogy. These beliefs enable the determination of priorities in teaching. Similarly, teachers' beliefs affect the approaches they give importance while teaching mathematics and their style of implementing these approaches in classroom. Teachers' beliefs also indirectly affect their students' beliefs about learning and teaching mathematics. During the process of teaching and learning mathematics, student's beliefs are shaped by experiences in classroom settings and they play an active role in the process of student learning. Pre-service teachers' beliefs that they hold during their higher education affect their learning in teacher education programs and also their teachings in the future. In this study, mathematical beliefs include the beliefs related to the nature of, the teaching and learning of mathematics. Beswick (2011) defined mathematical beliefs as what individuals believe to be true about the discipline of mathematics as well as its teaching and learning that shape teaching practice. Ernest (1989) stressed that to design effective and meaningful learning environments, it is important to identify and comprehend individual teaches' beliefs in relation to mathematics education. Pedagogical beliefs of teachers including beliefs about what teachers should do to assist pupils learn mathematics.

Mathematical beliefs are explored by different researchers in various ways and classified into different groups (Chan & Elliot, 2004; De Corte, Op't Eynde & Verschaffel, 2002; Ernest, 1989; Lerman, 1986; Perry, Howard & Tracey, 1999). In these researches some of the same belief groups are named differently and this is not very important (Thompson, 1992). Whole of the views and approaches that are the bases of these categories are accepted as models. We get help from these belief models by considering them as a guide for our study. Perry, Howard and Tracey (1999) categorized the orientations of teachers towards each of these components as transmission and child-centered. The dichotomy is important since personal philosophies describe the teacher's view of the student's role in classroom as active or passive, as receiver or inventor of knowledge, or dependent or self-directed (Ernest, 1989). Swan (2006) postulated that an individual teacher's beliefs in relation to mathematics teaching and learning could combine elements of each of them, even where they could be inconsistent and contradict each other. Similar to this study, mathematical beliefs are labelled as a traditional and constructivist perspective reported in the literature (Chan & Elliot, 2004; Perry, Howard & Tracey, 1999). Teachers who hold traditional beliefs accept mathematics as a set of tools composed of unrelated rules and skills. So, they consider mathematics teaching as enabling students to have competences in these rules and abilities. That is to say, teachers with the traditional oriented beliefs pay particular attention to verification of knowledge in which memorization of rules and procedures are important. In this regard, mathematics teaching meant transmitting a set of mathematical facts and rules to pupils. The role of teachers in this sense is to show mathematical rules to students who are in the position of passive listener (Chan & Elliot, 2004). Teachers holding a constructivist-oriented beliefs are inclined to support the idea that students are able to build their own mathematical knowledge through negotiation of meaning. Teachers are charged with the role of creating learning environments and facilitating pupil's investigation of ideas through a variety of hands-on mathematical activities. According to teachers holding these beliefs, mathematics is a continuously expanding area that is dynamic and problem-based and that has knowledge generation process (Ernest, 1989). These teachers believe that effective mathematics teaching is in classroom settings where students understand concepts with the help of teaching materials.

Relationships between Mathematical Beliefs and its Teaching

Swan (2006) has tried to categorise teachers' teaching practices, such as teacher or learner based, in a variety of ways. It was found that teachers' actions in classroom could be different based on the notion they are teaching, and the kinds of curricula materials exploited. Additionally, teachers' accounts related to their teaching practices naturally align with observed teaching practices (Swan, 2006). Many scholars have also argued that beliefs of teachers related to the mathematics have a direct effect on pedagogical decisions and so teaching practice has been examined by a number of researchers to explore this link (Polly, McGee, Wang, Lambert, Pugalee & Johnson, 2013; Skott, 2009; Speer, 2005). For instance, study by Cross (2009) found that teachers who hold constructivist oriented mathematical belief were more likely to adapt learner centred activities in the classroom than teachers who hold traditional oriented mathematical belief. However, interestingly, this is contrary to a study conducted by Liljedahl, Rösken, and Rolka (2006) who reported that there was a misalignment amongst seven pre-service teachers' mathematical beliefs and their enacted beliefs. This inconsistency in relationship between beliefs and actions can be explained through some social issues involving school culture, busy schedule and expectations of families that affecting classroom practice. Speer (2005) suggests that exploration of the relations between beliefs and practice are still important since there are no clear elucidations for building and shifting teachers'

pedagogical practices. It is difficult to explain this interrelation in a simple way; it arises as a result of several effects and contexts' interaction in complicated ways. As beliefs are complex structures (Pajares, 1992), teachers' past experiences in mathematics, the nature of teacher-student interaction and school settings affect this interrelation both directly and indirectly. In order to eliminate the inconsistency between belief and teaching practice, Speer (2005) mentions that it will be more effective to gather data about teaching practices of teachers in classrooms first and then to gather data about beliefs upon these practices. Therefore, in this study a similar approach is used. The aim of the study was to explore the relationship between pre-service teachers' pedagogical beliefs related to teaching activities and their initial teaching actions in real classroom setting. The specific research questions are explored as follows: 1. What subject-matter beliefs do pre-service teachers hold with regard to teaching and learning of mathematics education in terms of traditional or constructivist perspective during their teacher education program? 2. How are teachers' mathematical beliefs associated with their teaching practices in mathematics during their period of school-based practicum?

Method

A case study research design was used in this study so as to obtain in-depth information about pre-service teachers' beliefs and their teaching actions. A case study is a preferred research design of the current study since Merriam (1988) described this as an "examination of a specific phenomenon such as a program, an event, a person, a process, an institution, or a social group" (p. 9). Case study is researchers' in-depth analysis of one or more cases /events about an individual or people (Cressvell, 2009). They can be used in researches that focus on the research question 'how', too (Yin, 2009). For this reason, case study research design is used in this study as pre-service teachers' beliefs about mathematics and their teaching are analyzed deeply.

Participants of the Study

The sample in this study for qualitative data comprise of nine pre-service teachers from Faculty of Education at the University of Artvin Coruh. Non-probability sampling is used in situations where it is not essential to generalize to a large population. The pre-service teachers participated in the study are involved in research on the basis of voluntariness requirement. As part of their courses on the field of mathematics, pre-service primary teachers in Turkey enroll for Mathematics I and II courses in the first year of their teacher education program. On the other hand, as part of courses related to mathematics teaching they enroll for Teaching Mathematics I and II in the third year of their university education.

Moreover, they take the courses 'School Experience' and 'Teaching Practice I and II' in third and fourth year. These courses enable pre-service teachers to gain teaching skills in classroom settings and by this way they are able to teach a specific topic or more topics in a planned way (Ministry of National Education (MONE), 1998). After their graduation from universities, pre-service teachers start their teaching profession if they get enough score in Civil Servant Selection Examination. After the teachers start their profession, they teach in elementary schools which are the most significant schools in education. They involve in teaching and learning process of compulsory mathematics courses for 6-10 years old students at these schools. Pre-service classroom teachers are coded with T1, T2, T3, T4, T5, T6, T7, T8, T9 parameters.

Data Generation Methods

In this study in order to investigate pre-service teachers' beliefs about mathematics and also about teaching and learning that they hold during their teaching practises, different data generation methods are used. An interview form is used for detecting the pre-service teachers' general beliefs about mathematics. With interviews, their general beliefs about mathematics and also about the setting of mathematics teaching and learning are tried to be detected. Moreover, in order to find out whether there is consistency between teachers' beliefs about teaching and their practices in classroom, observation method is used. Stimulated recall is conducted just after the in-class observation in order to find out teachers' beliefs about environment of mathematics teaching and learning. By this way pre-service teachers' beliefs about teaching practices of mathematics are explored deeply. Through triangulation data, I employed three different data tools: an observation for one-term school period, researchers' field notes, and open-ended interview form. The connection between data and analysis is inextricably connected. Observation helps researchers to notice several dynamics in classroom settings that cannot be detected via other tools. Observation is researchers' taking field notes about activities of an individual in a research setting. While taking the field notes, researchers record the events occurred in research setting in a structured (structured means

that the researcher asks the questions determined before for which the study seeks answers) or unstructured way (Cresswell, 2009). Observation that is not completely structured is used in this study. For Teaching Practise course, pre-service teachers practise their teachings in primary schools. During 2016-2017 education years, in fall and spring semester, pre-service teachers' processes of teaching and learning mathematics are observed in these schools. For this observation, an evaluation form that consists of open-ended questions is prepared by the researchers. This evaluation paper is put into its final form after experts' opinions are taken. During the process of observation, researchers take field notes about the teaching and learning environment that is provided by pre-service teachers for their students.

For the corroboration of the field notes taken by researchers, several photographs of the learning environment created by pre-service teachers are taken in the classroom. Researchers gather data by considering several issues like motivating students, design of the learning environment, efficiency of activities, roles of teachers and students in classroom and contribution of evaluation. For photograph taking in the class, researchers get the permission of the classroom teacher in order to address ethical considerations of the study. 9 pre-service teachers participated in study practise their mathematics teaching in 2nd and 4^{th} grades. Thus pre-service teachers are observed in different classrooms (2^{nd} and 4^{th} classes) at least two times.

The stimulate-recall interview method is described as a way of obtaining teachers' verbal commentaries of their thought processes (Calderhead, 1981). The use of stimulate-recall interview characterised an attempt to offer a concrete point of departure for the pre-service teachers to report their beliefs with regard to individual teaching practice. In order for in-depth analysis of pre-service teachers' beliefs about mathematics during the process of teaching and learning, face to face interviews are made just after each observation. In these interviews, questions related to the teaching- learning environment created by the pre-service teachers in mathematics classes are used. Pre-service teachers are asked to explain their views about teaching mathematics before they design the learning environment, during their implementation of the activities and after their teaching practice. By this way pre-service classroom teachers' beliefs about mathematics teaching are tried to be detected. Interviews made with each pre-service teachers are recorded.

In order for detecting pre-service teachers' mathematical beliefs, literature related with the topic is reviewed and then questions on the interview form are prepared with the help of other studies (Bütün, 2005; Dede & Karakuş, 2014; Ernest, 1989; Kul, 2013). Like observation form, this interview form is put into its final form after experts' opinions are taken. Similar with the other studies in literature, the questions on the form are divided into 3 main parts. Among the open-ended questions, two questions, "what mathematics really is? What would you answer?" and "What is the source of mathematical knowledge?" were related to the nature of mathematics. Two other questions, "What do you think is the best way to learn mathematics?" and "what do you do when you encounter difficulty in learning a mathematical concept or topic?" were related to the learning of mathematics. The last two questions, "What is the most effective way to learn mathematics?" and "What do you do when faced with teaching a mathematical topic that you don't exactly understand?" were related to the teaching of mathematics.

Data Analysis

Qualitative data analysis is conducted for this study because its nature necessitates qualitative data analysis paradigm. For this purpose, content analysis method is used in the study because for the analysis of data gathered through media content analysis can be used (Cohen, Manion and Morrison, 2007). Analysis is described as a continuing process of 'giving meaning' to impressions about data (Stake, 1995). The constant comparison method was also used so as to ascertain themes relevant to participants. Data are coded separately one by one by researchers. When there are different codes, researchers come together and reach to an agreement on these codes. By this way, the reliability of the study is established. On the other hand, in order to enhance the validity of the study, different data gathering tools are used. Thus, by getting more varied data in detail, the aim of the study is achieved. Researchers continuously control the functionality of each data generation tools in order to find out whether they effectively serve for the study or not. For this purpose, researchers add some questions to or omit some questions from interview and observation forms.

Results

This section of the study consist of two parts: Findings about pre-service teachers' mathematical beliefs and results related to pre-service teachers' beliefs about mathematics in the process of teaching and learning in classrooms.

Pre-service Teachers' Mathematical Beliefs

Teachers' mathematical beliefs are grouped as constructivist and traditional beliefs according to the analysis that meets the aims of the study. When pre-service teachers' mathematical beliefs are analysed, it can be said that they mostly have constructivist views on teaching and learning mathematics (See Table 1). Six participants out of nine (e.g. T3, T6) back up progressive methods of teaching mathematics which stressed that the learners can ascertain, solve problems and share their findings and approaches. This group also highlighted the aim of teaching was about allowing students to appreciate mathematics during teaching. Another remarkable result as it is seen in Table 1 is that all pre-service teachers have completely constructivist beliefs rather than traditional ones with respect to teacher and student roles in mathematics lessons. For instance, some pre-service teachers (e.g. T7, T9) hold the view that students learn mathematics best by "making and living" with help of peer interaction. They hold a strong belief about cooperative learning. Students in their classes are expected to be participated in cooperative problem solving and modelling activities, because according to them, learning is about attaining shared knowledge. The comment is consonant to constructivist-oriented mathematical beliefs where the pupil is active and the teacher's role is guide. However, when pre-service teachers' individual perceptions on mathematics are analyzed, and their mathematical beliefs are both traditional and constructivist.

When directed what pre-service teachers thought about mathematics, majority of them responded that mathematics is being useful to individuals for daily-life routines such as counting, marketing and measuring. Here is the example of pre-service teacher's written commentary: *"mathematics is about counting, computation, calculation, measuring and drawing can be used in solving problems faced with everyday life. People could be used mathematics to solve daily life problems. For example, Egyptians used mathematics as a counting when the Nile River overflowed and drenched agricultural fields (T6, participant writings)".* This prospective teacher considered mathematics as a vehicle for solving problems within the daily-routine activities, make it easier for his everyday life.

Table 1. Classification of pre-service teachers' mathematical belief systems

Mathematical Beliefs	**Traditional**	**Constructivist**
Individual perception on mathematics	T4, T8,	T7, T9
Importance of mathematics	T1	T2, T3, T5,T6, T9
Approaches towards learning	T1, T2, T8	T3,T4, T7,T9, , T5, T6
Approaches towards teaching	T1, T2, T3,T4, T5	T2,T3, T4, T5, T7, T8, T9
Teacher and student roles in mathematics education	---	T1, T2, T3, T4, T5, T6, T7, T8, T9

On the other hand, it can be said for the pre-service teachers who hold traditional beliefs that their perceptions on nature of mathematics direct them into traditional beliefs. A pre-service teacher (T4) with traditional beliefs about the source of mathematics mentions that *"For me, first mathematical knowledge is the knowledge I get from my mathematics teacher. Later, it goes on as secondary school and private courses. If we go back more, most probably my teacher learnt it from his own classroom teacher"*. It is seen that this teachers' view on mathematics is limited with the mathematics she learnt in school settings and the source of her mathematics knowledge is her teacher.

On the other hand, some of pre-service teachers' beliefs about mathematics are closed to both traditionalist and constructivist teaching beliefs (e. g. T2, T3, T4, T5). It was shared belief that learning abstract mathematical ideas through concrete materials is vital and viewing such connections would assist pupils to make sense of abstract concepts by introducing ideas from simple to complex. At the same time, they held the belief that concrete and visualization makes learning effective and permanent due to the immobility of mathematical objects. Here is the example: "*I think that the best way to learn mathematics is concretization since mathematics, mathematical knowledge and concepts are abstract and immobility. Students are only able to understand through visualization and concretization (T2, participant's writings)*".

Pre-service Teachers' Beliefs in relation to Teaching and Learning Processes

Results about pre-service teachers' beliefs about the process of teaching and learning mathematics are obtained from observations and stimulated-recall interviews. Analyzing data sets, beliefs are divided into 4 basic categories. These are teachers' designs of mathematical content, preparation of materials in mathematics class, learning environment that they establish during lessons and their assessment processes. Moreover, observation and field notes that support or do not support these findings are presented in an indicative way.

Table 2. Pre-service teachers' design of mathematical content knowledge

Mathematical Content	**Traditional**	**Constructivist**
The resources used for creating content	T2,T3,T5,T6,T8	T1,T3, T4, T5, T6,T7,T9
Diversities in mathematical content	T1, T2	T2, T3, T4, T6, T7,T8,T9
Concretization of mathematical content	T1,T2, T5, T6	T3, T4, T6, T7, T8, T9

Pre-service teachers' designs of mathematical content during the process of their teaching practices in classroom setting differ from each other. With respect to the results received from observations and interviews, sub categories are determined for teachers' designs of mathematical content. One of them is the teaching resources that teachers receive help from while designing the content. The others are phasing, diversifying and concretizing mathematical content. These sub categories are presented respectively. While pre-service teachers with traditional beliefs think that mathematical content cannot be changed, teachers with constructivist belief think it can be changed. They think that they should adjust the content according to the circumstances. Some of the pre-service teachers (T3, T5 and T6) have views that reflect both constructivist and traditional approaches. One of the teachers who hold both constructivist and traditional beliefs (T3) mentions that: *"the classroom teacher told me to do the activities in the book. Instead of doing them, I brought some fruit. I thought that if we solve problems together it would be better".* It is understood from this statement that her views are closer to constructivist approach. However in another statement of this pre-service teacher it is explained that *"…Actually I find this activity from the internet and download it. We usually prepare activity papers by this way".* It is understood that this pre-service teacher hold different kinds of beliefs about determining mathematical content. According to some of the pre-service teachers' statements about whether the mathematical content can be changed or not, it is seen that there are both constructivist and traditional oriented beliefs on this issue. One example that support this finding are given below:

> *T9: "When looked through the internet I learnt that there was such a story called Land of multiplication but I didn't copy the same story, I made some changes by myself."*

Pre-service teachers have different views about phasing the content in the process of designing mathematical content. The phases of mathematical content such as planning it and putting it in order…etc. are seen as a whole by the pre-service teachers who hold constructivist beliefs. One of the pre-service teachers' (T1) comments that support this finding is:

> *"I have prepared 5 questions and one of them was more complicated. I felt myself compulsory to start from simple questions since the students also had just started the lesson. So I wanted to design the content from simple to complex".*

This statement emphasized that this teacher sees the content as problem based rather than as a whole. It is seen from Table 2 that teachers also hold different beliefs about diversifying and concretizing the content of mathematics in teaching. Most of the pre-service teachers support constructivist approach while making the content diversified and concretized. Some of the pre-service teachers with traditional beliefs think that just visualizing the problem is enough for concretization. However, some of the pre-service teachers who hold constructivist beliefs think that in order to concretize the mathematical content it is necessary to bring a real object to the class or to use modeling method. Similarly, these teachers think that in order to diversify the content, giving examples from real life and associating the subject matter with real life is necessary. On the other hand the pre-service teachers having traditional oriented beliefs think that solving a lot of problems is a way of diversifying the content. The statements of the teachers supporting these results are given below:

> *T6: "I wrote problems on colorful cardboards and hang them on the board. If I had written each problem on the board one by one I would have solve fewer problems and it would have caused a loss of time…" (Traditional- Concretization)*

> *T2: "…because when examples from daily life are given, students will learn the subject matter more easily. More examples about measuring can be given. For instance I could have brought milk, too..." (Constructivist-Diversification)*

Table 3. Pre-service teachers' preparing materials in mathematics lesson

Materials in Mathematics Teaching	**Traditional**	**Constructivist**
The aim of preparing material	T1,T2,T5,T6, T8,	T2, T7,T4,T9
The functionality of the material	T1, T8,	T3, T5,T6 T7, T4. T9

Figure 1. Examples of the pictures of all characters, figures…etc. on the board

The common idea of all pre-service teachers is that it is necessary to prepare materials in order to arouse students' interest and concretize the concepts. Because of this, it is difficult to categorize teachers' beliefs as traditional or constructivist. However, the pre-service teachers who support constructivist approach mention that they need to prepare materials in order to make learning easier. Whereas the teachers who support traditional approach state it is necessary to prepare materials in order to make teaching easier. Some of the traditionalist teachers even think that there is no need for materials because students have understood the subject matter. Some of the statements of these teachers are given below with the field notes.

> *"If the students have just begun learning the subject matter, I would like to do something that will arouse their interest. But if they have already learnt it I may focus on more complicated problems. Rather than using concrete materials and without making too much effort, I may draw something on the board…" (T1)*

> *"While teaching fractions, the teacher delivered nuts to the students and with verbal instructions he constructed modeling. He tried to explain using questions such as "how many nuts are there for each of our 4 friends?" But the students did not gather the nut together for modeling. The pre-service teacher asked students to read the problem on course book before modeling…" (Field notes, 30.03.2016)*

When pre-service teachers' comments on the aims of material preparing are compared with their comments on functionality of materials, it is understood that there are more traditionalist beliefs compared to constructivist beliefs (See Table 3). Most of the pre-service teachers' perceptions on functionality of materials in classroom setting are closer to constructivist approach. These teachers think that students should be given opportunities for using materials. Thus, they focus on the necessity of a learning environment in which students actively use materials. The statement of them who support these ideas is: *"I usually make students to do all the things including the materials… Because of this, they enjoy the lesson…"*

It is also understood that T4 sees functionality of the material as students' opportunity for using it. Furthermore another pre-service teacher's statement is: *"The students are in concrete operational stage so if I just had written on the board it would have been abstract. As I showed them the box, they understood the topic better…"* T9 suggested that the functionality of the materials helps concretization of the subject matter. It is also observed that this teacher, whose beliefs are constructivist, designs activities using different materials in classroom setting while teaching the multiplication rules for 0 and 1. While students are doing these activities they are very active and they enjoy the class. One of the activities is called 'magic box'. The teacher explains the material's functionality as follows:

> *''I told the students that this is a magic box. In this green box I placed a hidden part beforehand. I stuck the symbol of multiplication on the middle of the box. I asked students how many spaghetti sticks would fall down when I put 5 of them in the box. They answered as 0. Then I omitted 0 and stuck 1instead of 0. I get 5 spaghetti sticks again and asked the students when 5 spaghetti sticks were multiplied by 1 how many of them would fall down. They answered as none of them. The students were mistaken because the box confused them. When I put the sticks and they fell down, students got shocked…"* (Observation, 16.03.2016).

The materials prepared by pre-service teachers are analyzed in terms of their aims and functionality. After this analysis it is seen that pre-service teachers who have different beliefs create different environments for teaching mathematics. Table 4 shows learning environments that are established by them.

Table 4. Learning environments established by pre-service teachers in mathematics education

Learning Environment	**Traditional**	**Constructivist**
Classroom management and organization	T8	T3, T4, T6, T7.T9
Student-teacher interaction	T1,T8	T1,T2, T3, T4,T6,T7,T9
The role of students and teachers	T1,T3,T8	T2,T4, T5, T6, T7, T9,
Approaches to teaching and learning	T1, T5,T8	T3,T4,T5,T6 T7.T9

From the data in Table 4, it is apparent that learning environment in mathematics education are explored in 4 sub-categories. There is only one pre-service teacher who has traditional beliefs about the arrangement of classroom setting in mathematics education. As most of the pre-service teachers have not made any comment on this sub category, the number of pre-service teachers who support traditional approach is very few. T8 who supports traditional approach for the arrangement of classroom, prefers conventional classroom design in order not to waste time. Her statement about this issue is: "*I thought that I could group the students but then I saw that each of them sits alone. So I deliver one by one rather than striving for grouping them…"*

As it is seen in Table 4, with respect to student-teacher interaction in mathematics lessons, most of the teachers have constructivist beliefs. One of the pre-service teachers who have constructivist beliefs about this issue mentions "*I thought a classroom setting in which all of the students involve the course and interact with the teacher. I wanted to interact with students and by this way most of the students attended the course…*" From this statement of T2 it is understood that there is teacher- student interaction in her class.

The pre-service teachers who have traditional beliefs about the roles of students and teachers think that they should lecture the topic by themselves. They should be more active especially in teaching the topics that students encounter for the first time. Some ideas of these traditionalist teachers about this issue are given below with their reasons:

> "*I think teacher should solve the first mathematical problem and explain it. The later problems should be solved by students. Because making students solve the first problem by themselves might be wrong….*" (T3-Traditionalist)

According to the teachers who have constructivist beliefs about the role of teachers and students, students should be active during lessons and teachers should guide them. However, although most of the pre-service teachers hold constructivist beliefs about teachers and students' role, it is seen that during their teaching practise they do not act on their beliefs. For instance, one of the pre-service teachers who have constructivist beliefs about the roles states that "*I would like to be a teacher who is loved by students and gets their opinion, behaves like their friend or their elder brother instead of behaving as a teacher who just aims to teach the subject and leave the class. Thus, my aim is always to be a good guide for them…"* According to this statement it is expected that this pre-service teacher's (T8) role in the class must be to guide students. However, from the observations made during his lessons, it is understood that he does not act on his mathematical beliefs (Observation, 31.03.2016).

With respect to teaching and learning strategies used in mathematics lesson, most of the pre-service teaches have constructivist beliefs but one of them holds different beliefs. For the teachers who hold constructivist beliefs, the lesson should be taught with the help of strategies that provide active participation of students. One of the field notes that supports this result is given below:

> "*It is observed that the pre-service teacher has designed a classroom setting that is founded on learning by doing theory. It is also seen that students are motivated while they are doing the activities. Students discuss together and find out how to fill different cups with same amount of water. The teacher is in the role of a guide during this process (T7; Observation, 31.03.2016)".*

However it is understood from participants' observations that some pre-service teachers use traditional teaching techniques in spite of their constructivist beliefs. Some of them even think that they use discovery learning theory most of the times. For instance, some statements of one of the pre-service teacher are: "*It was like a discovery; problems are also like that, as I asked to students…"* However it is understood from the observations that this teacher (T3) does not use discovery technique in class. Students do not reach the generalizations by themselves; the teacher explains them instead (Observation, 27.05.2016). The findings revealed that pre-service teachers make evaluations during their teaching practice and also they state that there is a need for an evaluation. In Table 5, the processes of pre-service teachers' evaluations are presented.

Table 5. The process of Pre-service teachers' evaluation in mathematics teaching

Assessment in mathematics education	**Traditional**	**Constructivist**
Assessment methods	T1, T2, T5, T8, T9	T4, T6, T7, T9
Types of feedback and their purposes	T2, T3, T5, T8	T1, T4, T6, T7, T9

When the pre-service teachers' mathematical beliefs are explored according to their evaluation methods in Mathematics lessons, it is understood that some of them who hold constructivist beliefs, perceive evaluation as an activity for students. As a result they think that evaluation should take place during the process of learning in order to make students active. On the other hand, the pre-service teachers with traditionalist beliefs perceive evaluation as asking true-false questions. One of their statements is *"I needed to ask them questions in order to find out which subjects they learnt just before my class and to what extend they learnt. I should make an assessment by asking questions and then teach the main subject matter 'proper fraction'".* I t is understood that T5 thinks it is necessary to make a summative assessment so as to determine whether the students learn the subject or not.

The prospective teachers who hold constructivist beliefs think that feedbacks and corrections should be quite clear and explanatory. One of these teachers (e.g.T9) mentions that "*When students couldn't understand the subject, I asked them to explain why we added up numerators but did not add up denominators. I didn't ask yes-no questions. For example; while adding 2/4 and 1/4, we added numerators and wrote 3/4 for the solution; I asked them why we couldn't write 3/8. I wanted them to explain this"*. It is also understood from this statement that explanatory feedbacks should be used both by teachers and students. However, the prospective teachers with traditional beliefs think that feedbacks and corrections can be accepted as useful whether they are explanatory or not.

Discussion and Conclusions

The aim of this study is to investigate the relationship between pre-service teachers' mathematical beliefs and their practices of mathematics teaching in real classroom settings in terms of some dimensions such as their way of designing of mathematical content, the approaches they use in teaching mathematics and their way of interaction with students. In this section, first mathematical beliefs of pre-service teachers and the themes that are categorized according to the beliefs of pre-service teachers that they hold in the process of teaching mathematics are discussed and then the results are given. The results of this study provide crucial insights related to the literature about the relationship between mathematical beliefs and teaching practice in classroom.

One of the main finding of the study is that pre-service teachers implemented beliefs interested in constructivism in their mathematics teaching. For instance, when the beliefs of pre-service teachers (e.g. T3 and T9) about teaching and learning mathematics are explored according to analysis of interview forms used in the study, it is found out they hold constructivist beliefs for most of the categories. They believe in the necessity of active student participation and student-centered teaching and they know the methods that focus on student centered teaching such as discovery and collaborative learning, inquiry and problem-based learning models. While pre-service teachers make comments on the importance of mathematics, most of them hold a common belief that mathematics is useful for people because there are a lot of areas in daily life that mathematics is used in. These beliefs of pre-service teachers are in line with some of the aims of both mathematics teaching programs of primary schools and teacher education programs that are revised in 2005. These aims include the target behaviors that students should gain such as being able to understand mathematical terms, relate these terms with others and use these terms and relations in daily life (MONE, 2013). Pre-service teachers' most beliefs correspond with these target behaviors and this shows that their beliefs are affected from the current teacher education programs and education system.

The ideas of some pre-service teachers who hold traditional beliefs about mathematics are restricted to their mathematics education they get during their past school years. They also see their past teachers as source of their mathematic knowledge. Moreover, these pre-service teachers with traditional teaching belief think that students' learning the subject matter by themselves is not enough and they state that it is necessary for teachers to explain the subject matter if students see that subject for the first time. The distinction on the nature of mathematics made by pre-service teachers who participated in this study can be seen in Beswick's (2012) study, too. In his study, it is found out that the participants have different and independent beliefs about nature of mathematics and they categorize mathematics as school and discipline. Teachers who consider mathematics as school mathematics think that mathematics is a set of instruments consisting rules and skills that are not interrelated. So they regard teaching mathematics as providing competences in these rules and skills (Ernest, 1989). These kinds of beliefs are widely held in school settings (Roulet, 1998). According to Lortie (1975), teachers first formulate their beliefs about teaching and learning when they are students at schools, then at teacher education programs. Moreover, after

they start their teaching profession, their beliefs are formed with their observations of their colleagues. These beliefs of pre-service teachers (e.g. T1 and T2) affect their designs of mathematical content, the kind of the materials that they use while teaching mathematics, the approaches they support during teaching, their interactions with students and lastly the kind of the evaluation methods they use. For example, T1 sees mathematics as a set of abstract rules, concepts and procedures for solving mathematical problems. Observations made during their teaching practice and also their statements show that these pre-service teachers believe mathematicians know how to apply all these rules and procedures in a suitable way and when to apply them. The teachers with this belief convey mathematical content to students and give opportunity to students for storing information.

From participants' comments about some of the sub categories, it is understood that their beliefs are close to both constructivist and traditional approaches. On the other hand, some of the pre-service teachers have no comments on these categories. According to Ernest (1989) teachers may hold different mathematical beliefs and there may be consonance or dissonance among these beliefs because they take part in different areas of belief systems. According to Green (1971) as beliefs systems are not completely logical systems, we may have beliefs that are not interrelated or that contradict with each other. This characteristic is because beliefs take place in our mind in small clusters and there is no link among these clusters.

In Haser's study (2006) teachers with Platonist views state that by focusing on just superficial elements, they use learner centred methods such as discovery learning and group work in classroom settings where they give information to students directly (where they do not facilitate the students to get information). These teachers mention that they pay regard to the relations among mathematical concepts and use materials just to raise student interest. Similarly, the pre-service teachers in our study know different strategies and methods for teaching mathematics and they express positive opinions about them however it is observed that they couldn't use these methods and techniques in real classroom settings in an appropriate way. For instance, although some pre-service teachers with constructivist teaching beliefs state that they bring real materials in classrooms in order to concretize some abstract concepts, it is seen that they use these materials mostly for attracting students' attention. So, this finding reveals it is not meaningful to classify pre-service teachers as totally constructivist or traditionalist.

According to the findings that reflect participants' beliefs about process of teaching mathematics, most pre-service teachers hold similar views on each of categories determined for this process: their design of mathematical content, learning-teaching environment they create, and the evaluation methods they use. It is also found out that these beliefs of pre-service teachers are consistent with their mathematical beliefs. Similar findings also exist in the studies of Cross (2009), Ogan-Bekiroglu and Akkoc (2009) and Polly *et al* (2013). Cross (2009) concludes that "there was greater alignment than misalignment between teachers' mathematics-related beliefs and their instructional practices" (p. 341). One of the pre-service teachers (T4) participated in this study use student-centered activities that support students to reach information by themselves during her teaching practice. Nevertheless, as she states that teachers are the source of the knowledge, it is understood that she holds traditionalist beliefs. According to Thompson (1992) the relation between beliefs about mathematics and beliefs on pedagogy and teaching is not clear and this relation is not like action-reaction; actually it is a complex relation.

The study made great efforts to observe pre-service teachers' current practice during the one term school period and determine their mathematical beliefs by asking open-ended written questions so as to reveal whether they are consistent each other or not. A collective case study of pre-service teachers illustrated that classrooms can be complex sites of social and cultural effects, and that the candidate teacher's mathematical beliefs were less conventional than their current teaching practice. Although there was a mutual relationship between the teachers' mathematical beliefs and their actions, the relationship between teachers' beliefs and classroom practice is dynamic with each influencing the other, but it is not easy to enlighten this relationship in a simple way.

Swan (2006) noted that any attempt to improve what mathematics teachers act in the classroom is contingent on the beliefs of those mathematics teachers. The beliefs that are held as a result of teachers' experiences can be brought into conformity with goals and learning outcomes of teaching programs. Teachers' university education is effective in enabling them to hold beliefs that help them in the process of teaching and support them for implementing the teaching activities that are aims of mathematics education reform. While evaluating their teaching practises, if teachers also evaluate their beliefs, they can find out the reasons for their inefficient teachings. Moreover, studies on beliefs about mathematics education should not only focus on what pre-service teachers believe but also why they hold these beliefs. Similarly, although teachers' beliefs are important there is a need for studies that investigate the relationship between the beliefs of teachers and students.

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