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Abstract

The need for constructivist classroom environments in mathematics teaching cannot be ignored in order for sustainable development to continue. One of the most important applications of constructivist classroom environments in mathematics education all over the world is mathematical activities. The proficiency of pre-service mathematics teachers in developing activities will support constructivist classroom environments. In this study, it was aimed to reveal pre-service mathematics teachers' thoughts about what points they consider while they develop activities for mathematics courses. With this aim, an open-ended question was addressed to 23 pre-service teachers taking education at Elementary Mathematics Teaching program of a state university and having received the elective course of *Activity Development in Mathematics Teaching*. The obtained data was analyzed via the content analysis method. As a result of the study, it was determined that the participant elementary pre-service mathematics teachers expressed the points which they considered while developing activities with a total of 161 sentences or words. The statements obtained as a result of the analysis of the answers which the pre-service teachers gave to the research problem were gathered and examined under five sub-themes, namely *general, purpose, scope, planning* and *the role of the teacher in practice*. In respect of the points which elementary pre-service mathematics teachers considered while developing activities for mathematics courses, participants considered while developing activities for mathematics courses, they were observed to use statements which were mostly related to the sub-theme of *the role of the teacher in practice*. When it was evaluated in general, it has been observed that the participant elementary pre-service mathematics teachers are generally aware of the points to be emphasized. However, due to the low number of pre-service teachers who emphasized some points, it was concluded that they did not have enough knowledge about developing activities

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Research Article

The Points to be Considered while Developing the Activities for the Mathematics Course *

Selin ÇENBERCİ [1]

Abstract

The need for constructivist classroom environments in mathematics teaching cannot be ignored in order for sustainable development to continue. One of the most important applications of constructivist classroom environments in mathematics education all over the world is mathematical activities. The proficiency of pre-service mathematics teachers in developing activities will support constructivist classroom environments. In this study, it was aimed to reveal pre-service mathematics teachers' thoughts about what points they consider while they develop activities for mathematics courses. With this aim, an open-ended question was addressed to 23 pre-service teachers taking education at Elementary Mathematics Teaching program of a state university and having received the elective course of *Activity Development in Mathematics Teaching*. The obtained data was analyzed via the content analysis method. As a result of the study, it was determined that the participant elementary pre-service mathematics teachers expressed the points which they considered while developing activities with a total of 161 sentences or words. The statements obtained as a result of the analysis of the answers which the pre-service teachers gave to the research problem were gathered and examined under five sub-themes, namely *general, purpose, scope, planning* and *the role of the teacher in practice*. In respect of the points which elementary pre-service mathematics teachers considered while developing activities for mathematics courses, participants considered while developing activities for mathematics courses, they were observed to use statements which were mostly related to the sub-theme of *the role of the teacher in practice*. When it was evaluated in general, it has been observed that the participant elementary pre-service mathematics teachers are generally aware of the points to be emphasized. However, due to the low number of pre-service teachers who emphasized some points, it was concluded that they did not have enough knowledge about developing activities.

Keywords: Activity development, mathematical activity, mathematics course, pre-service mathematics teacher

1. INTRODUCTION

The global changes lived in today's world make it necessary for countries to follow science and technology closely and perceive and use the changes. Stoblein (2009) states that students who attend a traditional class have a low level of understanding, because teachers do not provide opportunities to support students' thinking and learning process. In this context, countries have needed to revise their educational policies. As in the international in our country, too, from 2004 on, the Ministry of National Education (MoNE) has renewed the teaching programs according to the constructivist approach. İlhan and Aslaner (2022) emphasize that the majority of mathematical and geometric objects contain abstract concepts that require mental activity. Considering these abstract concepts and taking into account the changing educational philosophies, students are not expected to memorize formulas in mathematics teaching, but to reach the information actively in the process themselves. Together with this change, the learning-teaching processes of the programs, the tools used, the structures of classes and the teacher and student roles have also changed. The teacher has been taken from the position of giving students knowledge directly and brought into the position of supporting their learning and

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helping them learn (Saylan & Yurdakul, 2005). Student, however, have come into the position of being active in the process, being responsible of their own learning and constituting their new knowledge by starting from their previous knowledge (Umay, Duatepe, & Akkus-Cikla, 2005). Although knowledge is easily accessible, it is more important that the reached knowledge should be interpreted and used in problem situations. According to the constructivist approach, knowledge is not transferred literally from one individual to another, but an individual can be guided in his/her constructing the knowledge by choosing appropriate tasks (Dede, Dogan, & Aslan-Tutak, 2020). Within the mathematics teaching program based on constructivist approach, activities are attracting attention as the most important learning-teaching tool. In order to realize environment, teachers should design learning environments using mathematical activities to create efficient classrooms (Ayalon, Naftaliev, Levenson & Levy, 2021). It is emphasized by many scientists that mathematical activities have a very important place in the mathematics' teaching and learning (Crespo, 2003). In this context, the importance of activity-based learning should be emphasized It can be stated that this situation is also valid for courses other than mathematics. At this point Karatas and Cerci (2023) emphasize that activities are very necessary for language teaching in their studies.

In activity-based learning, it is thought that students will be held responsible for their own learning and their personal development will be supported (Festus, 2013). Placing the activities frequently mentioned in the program in the center of the learning-teaching process has put forward the importance of the activities and there has appeared a need for explaining this concept (Toprak, 2014). When the mathematics education literature is examined, it is seen that the English words "task" and "activity" are used in place of the Turkish word "etkinlik". The word "görev" can be used as the Turkish equivalent of the English word "task" and the word "aktivite" can be used as the Turkish equivalent of the English word "activity". When the meanings of these words within the mathematics learning and teaching environments are examined, it is seen that Doyle (1983; 1988) defines the word "task" as a mathematical situation on which students work without always participating actively and the word "activity" as a situation in which students work actively on a subject about which they have no information. However, Sullivan, Clarke and Clarke, (2013) define the term "task" both as a starting point for a student to learn and a process composed of context-based questions, situations and instructions and where a student's knowledge is required and the term "activity" as the thoughts, physical, written, verbal statements which students produce to answer the process included in the statement of a task. Yeo (2017) in the study, helped teachers select types of mathematical tasks that could help them design or select more appropriate tasks that would appeal to students with different abilities to develop different types of mathematical thinking processes. These tasks initiate activities, which provide the basis for learning to take place. In their study, Henningsen and Stein (1997) state that mathematical tasks included in activities will teach students mathematics and do mathematics. Many studies have been conducted on designing or modifying activities in mathematics education, as they draw attention to the important role of tasks in activities in students' mathematics learning. Lee, Lee and Park (2019) in their studies, he focuses on developing the skills of pre-service middle school teachers to change mathematical tasks through activities for noticing. Consequently, it can be stated that the development of pre-service teachers' noticing skills and this development affect their task changes. At the same time, it can be stated that they will develop a student's mathematical thinking and association skills.

Although there is a wide range of meanings for the concept of activity, there isn't a shared definition of it (Ozmantar, Bozkurt, Demir, Bingolbali & Anil, 2010; Ugurel & Bukova-Guzel, 2010). In traditional approaches, activity is expressed as a work created by students and prepared by the teacher following a certain path (Margolinas, 2013). According to Dede et al. (2020), activity is defined as learning activities which are in line with pedagogical approaches enabling students to focus on thoughts via various mathematical tasks. However, Bozkurt (2012) defines mathematical activity as

the generation of a product by activating a problem given for learning a piece of mathematical knowledge with the help of some materials and tasks given to students. Stein, Grover and Henningsen (1996) said that, activity is given as the classroom activities drawing students' attention to a certain mathematical thought. In addition to this an activity as the activities supporting students' learning and enhancing their learning levels (MacDonald, 2008). As pointed out by the definitions, in order to do an effective and qualified mathematical teaching enhancing students' learning levels, well-structured activities to activate students' meta-cognitive skills such as problem solving, search for a pattern, arriving at generalizations and develop their mathematical thinking should be taken into consideration. Each of the mathematical activities has a critical role for mathematical learning (NCTM, 2000). Simon and Tzur (2004) emphasizes that activities are attached importance with the aim of developing the teaching of a concept and increasing the quality of mathematical education in the USA. In order to realize the learning by understanding, it is important to teach students mathematical concepts and procedures and the relationships between these (Soylu & Soylu, 2006). Mathematical signs like terms, equations are either tool or objects in mathematical activities. For this reason, Wille (2020) emphasizes that sign activities are a part of mathematical activities.

In his study, Baki (2008) points to the importance of mathematical activities' giving concepts and relationships between concepts in a planned way. While Swan (2008) emphasizes students must be active participation in the process through activities, Doyle (1988) states that students should take responsibility in activities. Activities do not only have students be occupied with a task intensively, but they are also important in teachers' arranging the teaching environment effectively (Johnson & Clarke, 2017). According to this, it can be stated that an activity is a process achieving students' active participation in a teaching environment. This requires setting activities, which are to have students acquire new knowledge and take them in the center to work by starting from students' previous knowledge. Henningsen and Stein (1997) emphasizes that the activities allow students to develop their mathematical thinking and reasoning skills. Hence, it is inevitable that students should be provided with different learning ways (Stylianides & Stylianides, 2008). It can be said that students' learning mathematics with the help of activities is the basic building block of the learning process. For, students are expected to be mentally and physically active and go into an occupation in the learning process via learning activities. According to Stein et al. (1996), activities give students what they learn, their knowledge of mathematics and their perception of mathematics. If the fact that an activity is a very important phenomenon is taken into consideration, the importance of an activity design should also be emphasized in order to create the desired effect in teaching and the fact that an activity design is a process requiring care and attention should not be ignored. A well-designed, well-structured activities offer significant benefits to the learning-teaching process.

Although there are different viewpoints about activity development, there are also some common principles. Lappan and Biars (1995) mentioned the necessity of considering what students work on, what mathematical knowledge expected to appear as a result of the activity, what mathematical thoughts reveled by students and what mathematical concepts are composed by them while developing a mathematical activity. Ainley, Pratt and Hansen, (2006) proposed the principles of purpose and usefulness for activities. Ozmantar and Bingolbali (2009) synthesized the principles given in the literature for event design and implementation and presented them as "event design and implementation principles". The necessity of considering the following points during the development of an activity is emphasized: *"the purpose of the activity, inclusion of a daily life context, flexibility and introduction of process-related knowledge, classroom management, more than one starting points, materials/tools, teacher and student roles, students' background knowledge, students' difficulties and misconceptions, measurement and evaluation"* (Brousseau, 2002; Ozmantar & Bingolbali, 2009). If the teacher does not choose or plan appropriate activities for the readiness, mental and physical structure of the class, she may not get the expected result in the activity

implementation process (Henningsen & Stein, 1997). The activity planning and implementation knowledge of a teacher may both facilitate and aggravate students' understanding. Griffin (2009) underlined that a well-designed activity would not be sufficient to achieve the desired learning outcome. In other words, it should be emphasized that the activity is as important in the implementation phase as in the development phase. In addition, it is stated that in order to realize more meaningful and permanent learning, the correct and appropriate implementation of the activities as well as the design of the activities is an inevitable situation (Yeo, 2007).

Hence, it is of importance to develop teachers' activity development and implementation skills. Stein and Smith (1998) examined the activities in different stages as the activities given in the textbooks, adapted by the teacher to apply by the students in the classroom. However, before and after the activity, it should be evaluated and revised at many different stages (Liljedahl, Chernoff & Zazkis, 2007). Depending on this, it is necessary to investigate into how teachers and pre-service teachers develop, implement, evaluate and revise activities to achieve mathematical understanding.

When other studies are examined in the literature, there are studies that examine the perceptions of mathematics teachers and prospective teachers about the concept of activity from different perspectives (Bozkurt, 2012), types of mathematical learning activities (Ozgen, 2017), their opinions about learning activities (Toprak, Ugurel, Tuncer & Yigit-Koyunkaya, 2017; Ugurel et al., 2010), activity preparation and implementation processes (Ozturk & Isik, 2018), evaluation of mathematics course book activities (Kerpic & Bozkurt, 2011), effects of teacher and student roles on activity implementation process (Ozmantar & Aslan, 2017), examination of measurement and evaluation processes of implemented activities (Karakus & Yesilpinar, 2013).

In their study, Toprak et al., (2017) studied pre-service teachers' perceptions of mathematics learning activities. As a result of the study, they emphasized a lot of characteristics related to activities, but they determined that the pre-service mathematics teachers could not include these mentioned characteristics in the activities they developed. It was concluded that it would be appropriate to develop pre-service teachers' activity development skills. In his study, Ozgen (2017) examined the mathematical learning activities with regard to skills, purpose, mathematical competence and cognitive processes, and gave place to the examples related to the concept of function with the aim of concretizing different kinds of mathematics learning activities. In their study, Toprak, Ugurel and Tuncer, (2014) analyzed the activities developed by the pre-service teachers with respect to their purpose of design, the subject they chose and the way of implementation. Consequently, it was determined that the pre-service teachers preferred the subjects at different class levels in the mathematics teaching program more frequently in the design of an activity. It was observed that most of the developed activities aimed to develop learning and it was followed by the purpose of consolidating the concept. They reported that the pre-service teachers chose collaborative group work most at the stage of implementing the activities.

In his study, Gok (2019) aimed to examine the elementary pre-service teachers' thoughts about how they developed an activity about a subject and the activities which they designed. As a result of the study, it was concluded that they touched on the evaluation of an activity and the flexibility components a little in the activity development process. Moreover, it was also examined that the elementary pre-service mathematics teachers had challenges in many ways while preparing an activity.

Festus (2013) focused on strategies to realize activity-based learning in the mathematics classroom. Some different strategies such small group learning, classroom discussion and cooperative learning have been seen to be used. Kerpic and Bozkurt (2011) carried out a study to evaluate the activities included in elementary mathematics course book within the framework of activity design and implementation principles. It is remarkable that the examined activities were generally designed in accordance with the implementation and activity design principles such as the purpose of the activity, the students' background knowledge, the necessity of an activity's covering all students, the

appropriateness of materials to be used, student roles and measurement and evaluation. However, it was observed that some design principles, which are of importance in an activity design, such as the necessity of an activity's having more than one starting points, the determination of the teacher's role and the students' difficulties and misconceptions were not attached sufficient importance; moreover, the matters of time use and classroom management were not touched on at all. Urhan and Dost (2018) examined the activities in the 9th grade mathematics textbook of MoNE (2013). As a consequence of the study, it has been showed that the activities in the textbook are quantitatively rich but qualitatively insufficient, and however, some activities in the textbook can be transformed into a model building activity that meets the criteria. In their study, Bozkurt and Kuran (2016) examined the teachers' thoughts in relation to the implementation of the activities in the course books and activity development. Besides this, 65% of the teachers stated having tried activity development and organized these according to the class level.

In their study aiming to determine the elementary pre-service mathematics teachers' activity preparation processes, Ozturk and Isik (2018) reached the result that the pre-service teachers did not have sufficient experience and knowledge about activity preparation process. In addition to this, it was determined that the activities prepared by the pre-service teachers primarily aimed to have the students comprehend the subject and it was followed in order of frequency by the activities with the purpose of concretization and evaluation. Ozgen, (2019) the pre-service teachers' skills in associating mathematics with different disciplines were investigated in the activities they developed. When the activities were classified according to cognitive processes, it was observed that the interpretation and the composition types of activities were included the least; when they were classified according to mathematical skills and competence, it was seen that the activities related to generalization, proving and reasoning and the use of technology were included few in number. Literature studies made in this context was determined that the teachers had some difficulties in preparing activities and comprehending the purpose of performing activities (Karakus & Yesilpinar, 2013). Moreover, it was also determined that a great majority of the teachers fell short of turning the designed activities into a valuable experience for the students and needed professional development (Sullivan, Clarke & Clarke, 2013). So, this indicates that the process of the developing activities much less is known. For this reason, recently there has been growing interest in the stage of developing activities. The process of pre-service teachers' developing a mathematical activity requires considering many different situations. The fact that obtaining and examining opinions in this process will create awareness about the points to consider in activities which they are to develop as a teacher in the future is increasing the importance of the study. However, while developing activities, both they should be structured well and the attitudes of individuals to benefit from them should be considered (Horoks & Robert, 2007). Yuksel (2014) concluded in her study that activity-based teaching makes an important addition to students' mathematics attitude and performance. Huang and Lin (2012) studied learning activities designed based on the recognition of central cultural factors using the activity system. They showed that they could improve their students' mathematical learning within the complexity of these learning activities and the cultural flow in their development.

It is known that pre-service teachers and teachers play a determinant role in the preparation and implementation of activities (Kerpic, 2011). According to Lau (2021), pre-service teachers have faiths about different subject areas and develop new faiths while studying at universities. Teachers' beliefs about mathematics and mathematics teaching and accordingly their competencies, it is vital for improving the quality of mathematics teaching (Potari, 2020). In this respect, teachers and pre-service teachers' competences in preparing activities and in relation to the activity concept are increasing the importance of the study. When the complicated content of a mathematical activity is considered, it is of great importance to create information and awareness in relation to the inclusion of this into the teaching process. It is commonly suggested that this should be worked on.

Starting from here, it was intended in the study to reveal the elementary pre-service mathematics teachers' thoughts about the points which they considered while developing activities for mathematics courses. In the direction of this purpose, following research question explored *"What points are consider while developing activities for mathematics courses?"*.

2. METHOD

This section includes the information about the research model of the study, the sample of the study, the data collection process, the data analysis process.

2.1. Research Model

This is a qualitative, special case study which aims to reveal the points which the elementary pre-service mathematics teachers consider in the process of developing activities for mathematics courses. Case study is a qualitative research design. Such research designs in which one or several situations limited by the researcher are investigated in detail and in depth by using data collection methods (interviews, observations, documents, etc.) that include multiple information sources (Creswell, 2007).

2.2. Sample of the Study

This study was conducted with the elementary pre-service mathematics teachers taking education at the Elementary Mathematics Teaching program of a state university and having received Developing Activities in Mathematics Teaching as a field education elective course. In the content of this elective course, after the theoretical explanation of the purpose and importance of the use of activities in mathematics teaching, the characteristics of the activities used in mathematics teaching, what should be considered when preparing and applying the activity, how the activities are evaluated (Council of Higher Education, 2018), the sample activities were examined. Afterwards, students were asked to design an activity and apply these activities in the classroom. At the end of this course the study was conducted with 23 elementary pre-service mathematics teachers based on the principle of voluntariness. The sample group was determined according to the easily accessible sampling method, which is one of the purposeful sampling methods, (Yildirim & Simsek, 2005).

2.3. Data Collection

Within the scope of the study, the participant elementary pre-service mathematics teachers were addressed in written form an open-ended question stated as "What points you are consider while developing activities for mathematics courses?".

The administration lasted about 30 minutes and the pre-service teachers answered freely the open-ended question addressed to them. It was assumed that all the participant pre-service teachers answered correctly and sincerely. In the study, the pre-service teachers were coded as "P1, P2..." while analyzing the data.

2.4. Data Analysis

In this study, in the process of making sense of the data, the content analysis method was used. Content analysis is a process starting with data collection and ending with category and code assignment and where data is interpreted and synthesized by researchers (McMillan & Schumacher, 2010). In this study, firstly, detailed coding and thematic coding were made; then, the data was organized according to the appearing codes and themes; finally, the findings were interpreted. While coding the data, the answers given by the pre-service teachers to the open-ended question addressed to them were read many times at different times and the data remaining outside the research questions were not coded by considering the conceptual framework of the study and, hence, the important dimensions that matter were determined within the framework of the study. Similarities and differences between the appearing codes were determined and the related codes were gathered together. In conclusion, the themes at general level and the sub-themes under these themes were determined and the codes were organized under these themes. Hence, the themes and the sub-themes

and the codes were created and tabulated. Some quotations were given directly from the students and interpreted.

In the study, the research question helping to obtain the research data composed the theme at the most general level. For this theme obtained from the data of the study, five different sub-themes, namely general, purpose, scope, planning and the role of the teacher in implementation, were determined. The codes were determined by considering the answers of the pre-service teachers and the findings including these codes and themes were interpreted. The example statements of some of the elementary pre-service mathematics teachers were given place directly. In this process, the data obtained in written form in the study was analyzed via frequency analysis by making it undergo the processes of the content analysis mentioned above in detail and the numerical data was obtained by using Microsoft Excel.

At the stage of content analysis, attention was paid to make the appearing themes constitute a meaningful whole between one another while making a thematic coding although they were different and the internal consistency and external consistency principles were taken into consideration. Within the scope of the validity and reliability of this qualitative study (Yıldırım & Simsek, 2005), plausibility and consistency were achieved through expert examination in this study. The data obtained were evaluated by two researchers and the similarities and differences were discussed between them. The way how the data obtained in this process was gathered under the determined theme and which sub-themes and codes would take place under this theme were determined together. At this stage, the matter of under which sub-theme the code of addressing different learning styles would take place was thought again and again. It was thought that this code could also have taken place under the sub-theme of scope, but it took place within the scope of the sub-theme of planning by considering the pre-service teachers' statements. Hence, the quality of the study tried to be increased. Afterwards, an expert review was conducted. Moreover, care was taken to classify the research data in accordance with the content analysis, its organization in line with the determined theme, its interpretation and its explanation via giving place to some direct quotations.

In the writing of the report related to the research findings, too, attention was paid to the research data's bearing such characteristics as being reasonable, appropriate for individuals' experiences, plausible, important and legible.

3. FINDINGS and INTERPRETATION

In this part, the findings reached as a result of the analyses made with the aim of examining the points which the participant elementary pre-service mathematics teachers consider while developing activities for mathematics courses by taking the pre-service teachers' answers to the open-ended question into consideration and the interpretations made in relation to these findings were given place.

As a consequences of the analyses, it was decided to accept the research problem as the theme in this study. In relation to this theme, it was determined that the elementary pre-service mathematics teachers stated the points which they took into consideration while developing activities with a total of 161 sentences or words.

Statements reached as a result of the analyzes of the answers given by the pre-service teachers to the research problem were examined under five sub-themes, namely *general*, *purpose*, *scope*, *planning* and *the role of the teacher in implementation.* Moreover, the percentage and frequency values reached as a result of gathering the answers given by the pre-service mathematics teachers to the research problem under these five different sub-themes were given in Table 1, too.

Table 1. Distribution of the sub-themes belonging to the knowledge of the pre-service teachers about the points which they consider while developing activities

	Frequency (f)	Percentage (%)
General	8	4.96
Purpose	23	14.28
Scope	23	14.28
Planning	47	29.19
Role of the teacher in implementation	60	37.29
Total	**161**	**100.00**

In the analyses made in the study, it was observed that the statements of the participant pre-service teachers in relation to their knowledge in the process of developing activities for mathematic courses were the ones which they most frequently used (37.29%) in relation to the sub-theme of *the role of the teacher in implementation*. This indicates that the pre-service teachers were aware of the importance of the role of the teacher in implementation in the process of preparing activities. However, the participant pre-service mathematics teachers focused, in order of frequency, on the sub-themes of *planning* (29.19%), *scope* (14.28%), *purpose* (14.28%) and then *general*. It was also observed that the statements used by the pre-service teachers least frequently (4.96%) were the ones which focused on the sub-theme of *general*. This indicates that the pre-service mathematics teachers underwent the process of developing an activity by performing the planning via considering the purpose, on the one hand, and by keeping the role of the teacher in implementation in the back of their minds without disregarding the scope, on the other hand.

The codes determined within the scope of the sub-themes related to the knowledge of the participant pre-service mathematics teachers in the process of developing activities for mathematics courses were explained in detail in the following tables. In Table 2, the frequency and percentage values related to the codes appearing in relation to the pre-service mathematics teachers' *scope*, *purpose* and *general* sub-themes were included.

Table 2. Frequency and percentage values related to the codes within the scope of the pre-service teachers' General, Purpose and Scope Sub-Themes

General	**Frequency (f)**	**Percentage(%)**
Practicability	3	37.5
Being economical	5	62.5
Total	**8**	**100.00**
Purpose		
Having the aiming at reinforcing concepts	1	4.34
Being appropriate for the new or determined acquisition	20	86.95
Providing permanent learning	2	8.69
Total	**23**	**100.00**
Scope		
Being attractive and avocatory	7	30.43
Establishing relationships between concepts or with daily life	14	60.86
Being in line with the principle of flexibility	1	4.34
Being in accordance with the requirements of teaching programs	1	4.34
Total	**23**	**100.00**

It was seen that the elementary pre-service mathematics teachers made the fewest statements about the sub-theme of *general*, an important part of which (62.5%) was composed of the code of *being economical* and 37.5% of which was composed of the code of *practicability*. The participant pre-service mathematics teachers' example statements about the sub-category of *general* were included. In this scope, while P1-coded pre-service teacher said the following while emphasizing the applicability of the activity. *"A developed activity should be applicable in the classroom environment"*. P18-coded pre-service teacher drew attention to the activity's requiring to be economical by stating that *"an activity should be appropriate in terms of cost".*

Within the scope of the sub-theme of purpose (86.95%), especially that of *being appropriate for a new or determined acquisition* was the most frequently stated code. This is rather important in terms of showing the pre-service teachers' awareness of the purpose of developing an activity in accordance with an acquisition. This situation *indicates* the pre-service teachers' preferring to plan an activity in order to teach an acquisition. Moreover, the statement which the pre-service mathematics teachers uttered most frequently was related to the code of *being appropriate for a new or determined acquisition*. Almost all of the pre-service teachers' being aware of the activity's requiring to be appropriate for the acquisition is important in terms of their comprehending the acquisition-activity relationship. In this scope, P3-coded pre-service teacher laid emphasis on the purpose of being appropriate for the acquisition by stating that *"attention is paid to the appropriateness of the developed activity for the acquisition"*

However, it is attracting attention that only one pre-service teacher stated the purpose expressed via the code of *aiming at reinforcing concepts* (4.34%). This situation indicates that the pre-service mathematics teachers preferred to prepare an activity during teaching a subject, but they did not prefer to use an activity in an implementation.

In the sub-theme of *scope*, the code of *establishing a relationship between concepts or with daily life* (60.86%) was the most-frequently preferred code. This situation indicates the importance given by the pre-service teachers to relationships both with daily life and between concepts while developing activities. The situation attracting attention in this sub-theme is the small number of pre-service teachers preferring the code of *being in line with the principle of flexibility and the requirements of teaching programs*. This indicates that the pre-service teachers disregarded the planning of alternative situations against unexpected situations in the process of preparing an activity. On the other hand, when we consider the statement made by P12-coded pre-service teacher expressed as *"I pay attention to the activity's establishing an association with daily life"* and the statement made by P14-coded pre-service teacher expressed as "*I pay attention to the activity's establishing a relationship between subjects"*, it is found that the pre-service teachers acted by paying attention to the mathematical association under the sub-theme of scope. Moreover, P14-coded pre-service teacher's statement of

"*I pay attention to the activity's attracting students' attention and interest"*

shows us the importance of activities' attracting students' attention.

Table 3 and Table 4 includes the codes used for the points which the participant pre-service mathematics teachers considered while developing activities for mathematics courses are the scope of the sub-themes of *planning* and *the role of the teacher in implementation*, example statements and the frequency and percentage values of these codes.

Table 3. Frequency and percentage values of the pre-service mathematics teachers in relation to the codes used within the scope of the sub-themes of Planning

Planning	Frequency (f)	Percentage (%)
Determining the students' individual or group works	1	2.12
Planning the implementation by considering the students' class levels, background knowledge and readiness levels	15	31.91
Determining correct implementation methods	3	6.38
Allowing for group and class discussions	3	6.38
Planning the effective use of time and duration	3	6.38
Use of materials and tools which are appropriate for acquisitions	1	2.12
Activity's including sequence and guidance	1	2.12
Classroom organization /organizing the physical environment	4	8.51
Planning evaluation	2	4.25
Being clear, understandable, effective in explaining the given subject	7	14.89
Reaching target	4	8.51
Considering different learning styles	1	2.12
Achieving the understandability of instructions	2	4.25
Total	47	100.00

Table 4. Frequency and percentage values of the pre-service mathematics teachers in relation to the codes used within the scope of the sub-themes The role of the teacher in implementation

Role of the Teacher in Implementation	Frequency (f)	Percentage (%)
Achieving the use of materials in a way which is appropriate for the activity, supportive and facilitates learning	6	10
Providing social interaction and communication	2	3.33
Informing students about the tools and materials used in the activity	3	5
Having students participate actively	22	36.66
The teacher's becoming a role model for students through guiding	17	28.33
Allowing students to learn by themselves	4	6.66
Having students discuss on the given concept by confronting them with alternative interpretations	3	5
Having a good command of the subject	1	1.66
Making the student the owner of the activity	2	3.33
Total	60	100.00

The code of *"planning the implementation by considering the students' class level, background knowledge and readiness levels"* occupies the biggest place (31.91%) among the pre-service teachers' statements about the sub-theme of planning. P10-coded student's statement of *"an implementation should be prepared in accordance with the readiness levels of students"* can be given as an example statement for this sub-theme. Planning the activity by checking the students' class level, background knowledge and readiness levels is an indication of the students' acting by being aware of what they know and don't know in relation to the subject. And this is vital in terms of bridging previous knowledge with new knowledge. However, it is observed that the codes of "*the use of materials and tools which are appropriate for acquisitions, inclusion of sequence and guidance, determining students' individual and group work, considering students' different learning styles"* (1.72%) were the least stated codes. The following statement of the P9-coded pre-service teacher included in the sub-category of planning expressed as *"I pay attention to make the student the owner of the activity*" lays emphasis on the importance of the teacher's having the student active in accordance with the constructivist approach. In addition to this, the statement of P11-coded pre-service teacher expressed

as *"I pay attention to class organization"* and the statement of P16-coded pre-service teacher expressed as *"the implementation duration of the activity should be determined well"* are an indication of the pre-service teachers' doing the planning by considering not only the activity itself but also the existing situations and the classroom environment during the implementation of the activity. It is attracting attention that P20-coded pre-service teacher having realized the importance of preparing an activity by considering not only the importance of the acquisition but also the students and their learning styles stated this with the following statement: *"I pay attention to the activity's addressing different learning styles".*

One of the points which the pre-service teachers took into consideration within the scope of the sub-theme of planning was the purpose of "*the activity's being clear, understandable, effective in explaining the subject"* (14.89%). And this statement emphasizes the necessity of the activity's being uncomplicated. Moreover, the pre-service teachers mentioned the necessity of the activity's aiming to achieve permanent learning.

Within the scope of the sub-category of "*the role of the teacher in implementation, the pre-service teachers focused on the codes of achieving students' active participation"* (36.66%) and then, being a role model by guiding (28.33%). And this shows us that designed activities by considering the constructivist approach. While the code of "*having a good command of the subject"* (1.66%) took place in the least-stated code category, the codes of "*achieving social interaction and communication and explaining how students will work"* took place in the next categories in the increasing order, which is in line with the pre-service teachers' acting by being aware of the communication at the point of guiding students while performing an activity in the classroom. When the example statements of the pre-service teachers, for example, that of P17-coded pre-service teacher expressed as *"attention should be paid to make the student active and the teacher be a guide"* that of P13-coded pre-service teacher expressed as *"I pay attention to its being an activity in which the student will be active"* and that of P16-coded pre-service teacher expressed as *"the student should be able to reach information by him/herself at the end of the activity"* are considered, the answers given by the pre-service teachers within the scope of the role of the teacher in the implementation of an activity show us that they tended to develop an activity according to the constructivist approach. However, P9-coded pre-service teacher's statement expressed as "I pay attention to make the student the owner of the activity" lays emphasis on the importance of the teacher's making the student active in accordance with the constructivist approach.

4. DISCUSSION, CONCLUSION and SUGGESTIONS

In this study aiming to reveal the elementary pre-service mathematics teachers' thoughts about the points to which they paid attention while developing activities for mathematics courses, it was observed from the answers given to the research question that the pre-service teachers indicated their thoughts about the research problem via a lot of statements. The participant pre-service teachers' statements including the points to which they paid attention to while developing activities for mathematics courses were gathered under five different sub-themes. It was obtained that the pre-service teachers mostly used the statements related the sub-theme of *the role of the teacher in implementation*. This indicates that the pre-service teachers considered the implementation process and the role of the teacher in implementation while developing an activity and this is very important case. This shows us that the participants are aware of how important the implementation process of the activities is. However, the participant pre-service mathematics teachers focused in order of frequency on the sub-themes of *planning* and then *purpose and scope* and *general*. Not just planning since well-determination of purposes and scpoe in an activity will affect the efficiency of the activity, it is important to determine purposes and scope. And the obtained results indicate that the pre-service

mathematics teachers were aware of this.

The answers which the pre-service teachers gave within the scope of the sub-theme of the role of the teacher in implementation indicate that they focused on the student's being active and the teacher's being a role model and tended to develop activities according to the constructivist approach. Active participation of students will support reasoning and thinking skills that will enable them to build new knowledge on top of their old knowledge. The codes of *providing social interaction and communication and having students discuss on the given concept by confronting them with alternative interpretations* are in accord with the pre-service teachers' acting by being aware of the communication at the point of guiding students while performing an activity in the classroom. The emphasis laid on making students active via the code of making the student the owner of the activity is attracting attention. Ozturk and Isik (2018) stated that the pre-service teachers took the students' levels and active participations into consideration while preparing activities, which seems to support the findings of the study. In addition to these, the emphasis of the pre-service teachers on the point of ensuring that the materials are used in a way that is suitable for the activity, supportive and facilitating learning is also very important. The thoughts that the materials used can create an obstacle to learning if they are not applied with a planning that supports teaching and facilitates learning (Bell, 1993; Swan, 2008) support the results of the study.

Within the scope of the sub-theme of *purpose*, especially the code of *being appropriate for a new or determined acquisition* is rather important in that it indicates the pre-service teachers' being aware of the purpose of performing an activity which is appropriate for an acquisition. Studies in which it is emphasized that activities should be suitable for learning outcomes (Ainley et al., 2006; MacGrekor, 2004; Ozmantar & Bingolbali, 2010; Stylianides & Stylianides, 2008) also support the results of the research. However, when we consider the importance of determining a purpose in different activities, the finding that the pre-service teachers planned an activity for the explanation of a new subject indicates that the pre-service teachers had top awareness levels. In contrary to this, that only one pre-service teacher expressed the purpose of *reinforcing* concepts indicates that the pre-service teachers preferred to prepare an activity during the teaching of a lesson, but they did not prefer to use an activity aiming at implementation or reinforcing. The results reached by Ozturk and Isik (2018) and Toprak et al., (2014) in the way that the activities developed under the component of purpose aimed to realize one learning at most and have students comprehend a new subject seem to parallel the findings of the present study. Contrary to this, the finding reached by Toprak et al., (2014) in the way that the second purpose was to reinforced the learned concept(s) contradicts with the ones which were obtained in this study. One of the points to which the pre-service teachers paid attention within the scope of the sub-theme of purpose was the activity's aiming to achieve permanent learning. Ugurel et al., (2010) state that activities should allow for permanent and effective learning, which seems to support the study's results.

In the sub-theme of *scope*, the code of *establishing a relationship between concepts or with daily life* was the most-preferred code. This indicates that the pre-service teachers generally attached importance to the establishment of mathematical relationships both with daily life and between concepts while developing activities. And this will make a contribution to their meaningful learning. Haciomeroglu's (2018) study which seems to support study's results. In addition, the studies stated that daily life situations should be included in the activities (Doerr, 2006; Stylianides & Stylianides, 2008; Francom & Gardner, 2014) support the results of the research. Another situation attracting attention in the sub-theme was that only a few pre-service teachers preferred the code of *being in line with the principle of flexibility*. And this indicates that the pre-service mathematics teachers ignored to plan alternative situations against unexpected situations in the process of developing an activity. Moreover, the statement of the pre-service teachers expressed as *"I pay attention to the activity's drawing students' attention and interest"* is an indication of how activities are important in attracting

students' attention. In the study made by Doyle (1988), the necessity of the activity's arousing students' interest and being accomplishable seems to support the result of the study. In addition to this, the fact that Brooks and Brooks, (1999) and Watson and Mason (2007) emphasize that the activities should be in a way that arouses curiosity, supports the result of the research.

Of the pre-service teachers' statements belonging to the sub-theme of *planning*, the code of *planning the implementation by considering the students' class levels, background knowledge and readiness levels* was the most-preferred code. Planning by considering students' grade levels, prior knowledge and readiness levels is an indication that pre-service teachers act by taking their knowledge into account. It is observed that the pre-service teachers were aware of the great importance of background knowledge to build a bridge between background knowledge and new knowledge. In their study, Ozmantar and Bingolbali (2009) mentioned the necessity of preparing activities in accordance with students' background knowledge because of the necessity of establishing association with their background knowledge in order to make the activity reach its purpose, which, at this point, supports the results of the study. The findings of the present study, which emphasized the necessity of taking students' background knowledge into consideration overlap the findings of the study made by Olkun and Toluk-Ucar, (2006) and Ozmantar and Bingolbali (2009). In their study, Elçi, Bukova-Guzel & Alkan, (2006) emphasized the importance of associating the activities with other disciplines and background knowledge while designing the activities, which supports the results of the present study. On the contrary, it was obtained that the codes of *using materials and tools which are appropriate for acquisitions, Including sequence and guidance, Determining students' individual or group works* were stated least frequently. In their study, Toprak et al., (2014) determined that the most-preferred implementation style was the teaching with a small (collaborative) group according to the implementation styles of the designed activities, which supports the findings of the study. In addition to this, the pre-service teachers' statements expressed as *"I pay attention to the class organization"* and *"the implementation duration of the activity should be determined well"* are an indication of the fact that the pre-service mathematics teachers did planning by considering not only the activity itself but also the classroom environment during the implementation of the activity. The study in which Swan (2007) emphasized the necessity of specifying how classroom organization is required to be in order to carry out an activity healthily supports the results of the study. In addition, encouraging the evaluation of a student's idea by the group (Ayalon & Even, 2016) is important in the organization of the classroom environment. Besides to this, the findings indicating the pre-service mathematics teachers' taking the classroom environment and the activity's implementation duration into consideration overlap those of the study made by Ozturk and Isik (2018). Not only that, Francis-Smythe and Robertson (1999) support the study's result that the teacher should predict both the time allotted for the activity and the attention to be paid during the use of this time. And this indicates that the pre-service mathematics teachers prepared the activity by taking not only the activity but also the situations existing when take into consideration the activity implementation.

Moreover, the elementary pre-service mathematics teachers made the fewest statements about the sub-theme of *general*. It was observed that while a considerable number of them used the code of *being economical*, fewer of them used the code of *practicability*. Although it was not stated by many pre-service teachers, the activity's being economical and practical in the classroom indicates that they are the situations considered at the last point. In fact, the interaction between the characteristics of the classroom and the teacher and the mathematical subject, on the one hand, activates the mathematical content that is open to learning in the classroom (Ayalon & Even, 2016), on the other hand, makes the activity practicable.

When we evaluated the study in the general sense, it was determined that while, on the one hand, the elementary pre-service mathematics teachers drew attention to many different points in relation to activity development, the number of the pre-service teachers laying emphasis on some

points was low, on the other hand. Because of the low number of pre-service teachers laying emphasis on some points, it was concluded that they did not have sufficient knowledge about developing activities. The result, which Ozturk and Isik (2018) obtained that the elementary pre-service teachers did not have sufficient knowledge and experience about preparing activities overlaps the results of the present study. In the context of all these results, the following suggestions are made:

- It is suggested that similar studies should be made to increase the awareness levels of pre-service mathematics teachers in relation to the concept of activity.
- Elementary pre-service mathematics teachers should be given applied courses aiming to develop their skills in relation to the process of developing activities.
- Pre-service mathematics teachers can be made to perform activity preparation works in the teaching practice course with the aim of having them acquire experience in relation to the activity development process.

Pre-service mathematics teachers can be given training to develop their insufficiencies having appeared as a result of the study in relation to activity development.

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