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TEACHING MATHEMATICS WITH GAMES ACCORDING TO PRE-SERVICE MATHEMATICS TEACHERS

MATEMATİK ÖĞRETMEN ADAYLARINA GÖRE OYUNLARLA
MATEMATİK ÖĞRETİMİ

Ebru KÜKEY¹
Esra MACİT²

Abstract

In this study, it is aimed to examine the opinions of pre-service mathematics teachers about teaching mathematics with games. This qualitative study was designed as phenomenological research. The study group consists of 26, 2nd grade students at primary school mathematics teaching department. In this context, first of all, "teaching mathematics with games" lesson was held with pre-service teachers for a semester. At the end of the semester, semi-structured interviews were conducted with the volunteer pre-service teachers. The obtained data were analyzed with content analysis and the data were divided into themes during the analysis process. As a result of examining the opinions of pre-service mathematics teachers on teaching mathematics with games, 6 themes were determined. These themes were named as "game preparation process", "features that should be found in games", "features that teachers should have", "benefits of games", "negative aspects of games" and "application problems". As a result of the study, it was concluded that the pre-service teachers emphasized that the games should be suitable for the mathematics achievements. They stated that the games should be appropriate for the grade levels, cognitive development and interests of the students as well as being suitable for the learning outcomes. It was emphasized by the pre-service teachers that teachers should be able to use different teaching methods and have a high imagination in order to develop games. In addition, it has been determined that teaching with games increases students' self-confidence, provides cooperative learning and affective development. In addition, it has been determined that the use of games in the classroom environment can negatively affect the course flow. In addition, it has been concluded that there may be a problem in practice because of the limited time during the course, which may create a time problem. Considering the results obtained, it is thought that teaching with games that can be used effectively in mathematics lessons will be beneficial.

Keywords: Teaching mathematics with games, teaching mathematics, prospective teachers.

¹ Res. Asst. Dr., Fırat University, Education Faculty, Department of Mathematics and Science Education, ekuey@firat.edu.tr, <https://orcid.org/0000-0002-2130-0884>.

² Dr, esramathedu@gmail.com, <https://orcid.org/0000-0002-2871-0915>.

Özet

Bu çalışmada matematik öğretmen adaylarının oyunlarla matematik öğretimine yönelik görüşlerinin incelenmesi amaçlanmıştır. Nitel olarak hazırlanan bu çalışma olgubilim araştırması şeklinde tasarlanmıştır. Çalışma grubunu 26 ilköğretim matematik öğretmenliği 2. sınıf öğrencileri oluşturmaktadır. Bu kapsamda öncelikle öğretmen adaylarıyla bir dönem boyunca oyunlarla matematik öğretimi dersi yapılmıştır. Dönem sonunda gönüllü olan öğretmen adaylarıyla yarı yapılandırılmış görüşmeler gerçekleştirilmiştir. Elde edilen veriler içerik analizi ile analiz edilmiş ve yapılan analizler sürecinde veriler temalara ayrılmıştır. Matematik öğretmen adaylarının oyunlarla matematik öğretimine yönelik olarak görüşlerinin incelenmesi sonucunda 6 tema belirlenmiştir. Bu temalar “oyun hazırlama süreci”, “oyunlarda bulunması gereken özellikler”, “öğretmenlerin sahip olması gereken özellikler”, “oyunların faydaları”, “oyunların olumsuz yönleri” ve “uygulama sorunları” olarak isimlendirilmiştir. Çalışma sonucunda öğretmen adaylarının, oyunların matematik kazanımlarına uygun olması gerektiğine vurgu yaptıkları sonucu elde edilmiştir. Oyunların kazanımlara uygun olmasının yanında sınıf seviyelerine, öğrencilerin bilişsel gelişimlerine ve ilgilerine de uygun olması gerektiğini ifade etmişlerdir. Öğretmenlerin oyun geliştirebilmeleri için öncelikle farklı öğretim yöntemlerini kullanabilmeleri ve yüksek hayal gücüne sahip olmaları gerektiği öğretmen adayları tarafından vurgulanmıştır. Ayrıca oyunlarla öğretimin öğrencilerin özgüvenini arttırdığı, işbirlikli öğrenmeyi ve duyuşsal gelişimlerini sağladığı tespit edilmiştir. Bunların yanında oyunların sınıf ortamında kullanılması sürecinde ders akışını olumsuz yönde etkileyebileceği belirlenmiştir. Ayrıca ders süresince kısıtlı bir zamandan dolayı zaman problemi oluşturabileceğinden uygulama sıkıntısı yaşanabileceği sonucuna ulaşılmıştır. Elde edilen sonuçlar göz önüne alındığında matematik derslerinde etkili şekilde kullanılacak oyunlarla öğretimin faydalı olacağı düşünülmektedir.

Anahtar Kelimeler: Oyunlarla matematik öğretimi, matematik öğretimi, öğretmen adayları

INTRODUCTION

Enriching learning environments with educational games is very important for an effective learning process to ensure permanent learning along with the development of individuals' mental and problem-solving skills (Türkoğlu & Uslu, 2016). Playing games is not the only action for fun, but has also been accepted as a good learning tool in recent years. (McNeil & Uttal, 2009). In this context, many studies examining games from various aspects emphasize the importance of the games in the learning process and provide pieces of evidence for their use in education (Dursun, 2014). In addition, studies show that teaching with games has a positive effect on increasing students' motivation, performance and success (Randel, Morris, Wetzal, & Whitehill, 1992).

Games constitute an important part of a student's physical, social, emotional, linguistic, and cognitive development. In addition, they are activities that are have used as an active learning process as a part of real life (Kaya & Elgün, 2015). At the same time, games have an important effect on the development of skills such as planning, strategic thinking, discussion, communication, data processing (Kirriemur & McFarlane, 2004), social development, the formation of rule awareness, belonging to the group, and acting as a group (Afari, Aldridge, Fraser, & Khine, 2013; Chen & Raley, 2013). In addition, it is very effective in increasing motivation (Rosas et al., 2003) and attention (Garris, Ahlers, & Driskell, 2002) on education. Similar to these features, the mathematics curriculum also aims to educate entrepreneurial students who can understand mathematics and apply it in daily life; It also aims at developing students' skills such as independent thinking, self-regulation, and decision making (MEB, 2018). In this respect, it is important to associate the activities in mathematics lessons with daily life (Baykul, 2014). The use of games in the teaching process also enables students with different learning methods to become active in the lesson, enabling them to develop positive attitudes towards mathematics (Katmada, Mavridis, & Tsiatso, 2014; Tural Sönmez, 2012).

Many mathematicians see games as math because of the relationship between math and games beside because games are rule-based (Bishop, 1991). While Faulkner (1995) expresses the game as a process based on real-life experiences that form the foundation of mathematical thinking; Umay (2002) expressed the relationship between games and mathematics as games are mostly mathematics and mathematics is mostly games. In this context, mathematical games can be expressed as tools in which mathematical thinking is used in developing ideas and finding solutions to problems (Holton, Ahmed, Williams, & Hill, 2001). On the other hand, mathematical games play an effective role in increasing students' motivation and participation in the lesson (Heshmati, Kersting, & Sutton, 2018). Along with increasing their motivation, it is also very effective in making the lessons more interesting (Offenhöle, 2012).

There is a prejudice in society that mathematics lessons are incomprehensible, boring, and difficult (Dulkadir, 2017). Similarly, it is has stated that many students see mathematics as boring (Orim & Ekwueme, 2011). It can be said that mathematics consists of abstract concepts among the reasons for having difficulties in mathematics (Altun, 2010). In addition to these difficulties, many intelligence games are based on the application of mathematical problems and concepts (Silva, 2011). Machaba (2019) refers to playing games as an important effort in the application of mathematical abilities. At the same time, establishing a relationship between games and students' own worlds is considered to be the most effective way to involve students in mathematics activities (Foster, 2004). It has been stated in various studies that it has an effect on students' developing positive attitudes towards mathematics with the help of games (Moomaw, 2015; Panagiotakopoulos, 2011; Ramani & Siegler, 2008). Similarly, various studies are showing that games are have used to support and evaluate the lesson (Demirbilek & Tamer, 2010; Kebritchi, Hirumi, & Bai, 2010). It has been stated in some studies that game has an important place in the development of children and that the use of the game in education has a very important effect (Insorio, 2020; Lampen, 2015; Nfon, 2018; Shaftel, Pass, & Schnabel, 2005; Silva, 2011; Yumuşak, 2014). In addition to this effect of the game, the teachers have a great influence on the participation of the games in the lesson in a way that contributes to learning (Lim-Teo, 1991). In this context, it is critical to determine the opinions and suggestions of prospective teachers, who are the teachers of the future, on the qualities of the games. With reference to this, in this study, it was aimed to examine the opinions of pre-service mathematics teachers who took the course "Teaching Mathematics with Games" on the use of games in education.

METHODOLOGY

Model of the Research

In this study, the views of pre-service mathematics teachers on the use of games in lessons were examined. The research carried out in this direction was designed as a phenomenology. Phenomenology studies focus on how individuals feel about a phenomenon, how they make sense of and perceive it, and how it describes and comes to a decision (Patton, 2002).

Participants

The study group of the research was determined by easily accessible sampling, one of the purposeful sampling methods. In this context, the study group consists of 2nd-grade students from the department of primary education mathematics teaching. The study was carried out with the voluntary participation of 26 pre-service teachers. Information about these pre-service teachers is given in the table below.

Table 1*Characteristics of Pre-Service Teachers*

Code	Class	Gender	Code	Class	Gender
PTM1	2	Male	PTF2	2	Female
PTM2	2	Male	PTF3	2	Female
PTM3	2	Male	PTF4	2	Female
PTM4	2	Male	PTF5	2	Female
PTM5	2	Male	PTF6	2	Female
PTM6	2	Male	PTF7	2	Female
PTM7	2	Male	PTF8	2	Female
PTM8	2	Male	PTF9	2	Female
PTM9	2	Male	PTF10	2	Female
PTM10	2	Male	PTF11	2	Female
PTM11	2	Male	PTF12	2	Female
PTM12	2	Male	PTF13	2	Female
PTF1	2	Female	PTF14	2	Female

When the table is examined, it is seen that there are 14 women in the study group, and they constitute 54% of the research. In addition, it was determined that there were 12 male participants in the study, and they constituted 46% of the study.

Data Collection Tools and Analysis of Data

Within the scope of the study, firstly, "The Teaching Mathematics with Games" course was conducted with pre-service teachers for a semester. Throughout the process, the effects of using games in teaching mathematics were examined from various aspects. At the end of the term, interviews were held with volunteer pre-service teachers. In these interviews, "Interview Form for Determining the Effect of Games in Mathematics Teaching" was used. There are five questions in the draft form of form. After examining the questions by expert educators, the final form consisting of three questions was prepared. Pilot interviews were conducted with three pre-service teachers to check the duration of the interviews and the clarity of the questions. Semi-structured interviews were have conducted with pre-service teachers upon necessary controls. During the interviews, it was has stated to the pre-service teachers that the conversations would be kept confidential and would not be used in any other place other than the study.

The data obtained after the interviews were analyzed with content analysis. Content analysis is the type of qualitative analysis that aims to bring together similar data within the scope of specific concepts and themes (Yıldırım & Şimşek, 2011). During the analysis of data, female pre-service teachers were represented by coding as PTF1, PTF2, Male pre-service teachers were coded as PTM1, PTM2, ... and analyzes of the study were made. The data obtained was coded by two independent researchers. In this way, the level of agreement between the codings was determined. The level of agreement between the codings was checked with the reliability formula of Miles and Huberman (1994). As a result of the analysis, the level of agreement between the codings was has determined as

91%. The differences between the coding made by the researchers were evaluated in line with their common opinions and decided. The themes created were supported by quotations obtained from interviews with pre-service teachers. In addition, which pre-service teachers expressed the themes were also indicated with the given coding. In this way, a basis for validity was established by transparently presenting the research.

FINDINGS

As a result of examining the opinions of pre-service mathematics teachers on teaching mathematics with games, 6 themes were determined. These themes were named as "game preparation process", "features that should be found in games", "features that teachers should have", "benefits of games", "negative aspects of games" and "application problems".

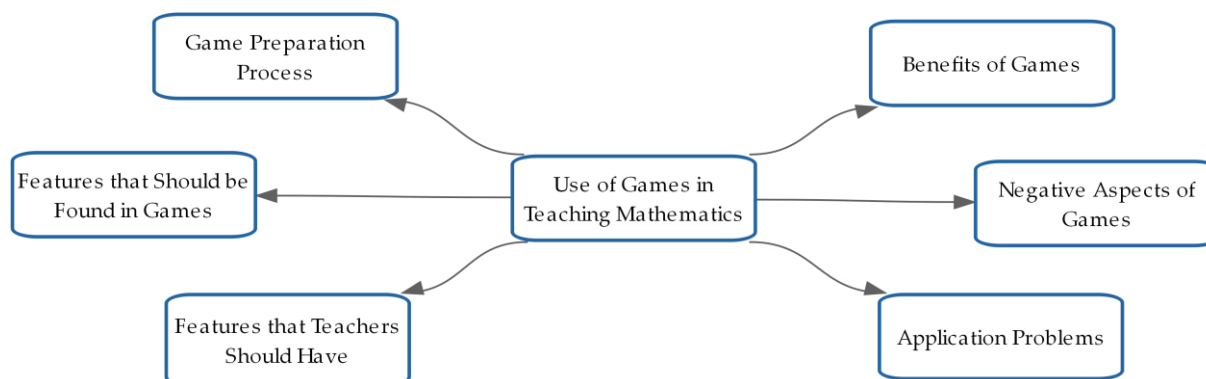


Figure 1. Use of Games in Teaching Mathematics- Themes

Findings of the Game Preparation Process

The features expressed by the pre-service teachers regarding the theme of "Game Preparation Process" are given in the table below.

Table 2. Theme 1-Game Preparation Process

Features	Pre-Service Teachers Codes	Frequency
Covering more than one learning outcomes	PTM6, PTM7, PTM4, PTF6, PTF7, PTF10, PTF11, PTF14	8
Being suitable for learning outcomes	PTM6, PTM7, PTF1, PTF14	4
Preparation requires attention	PTM6, PTF9	2
Long preparation time	PTF7	1

When the data were examined, it was determined that the pre-service teachers the most stated that the game should cover more than one acquisition. In addition, it has been determined that they have opinions that the games are suitable for the acquisitions, that their preparation requires attention and that the preparation process takes a long time. The opinions of some pre-service teachers regarding this theme are given below.

"One of the points noticed when associating games and mathematics learning outcome is that no learning outcome in mathematics is independent of another.." (PTF7)

"The teacher should pay attention to which game he will design and implement on which subject. Otherwise, incorrect learning that is difficult to return may occur. As a result, if we integrate the right games into our lessons where

necessary, students learn more easily and the information they learn will be more permanent. .” (PTF1)

“The teacher must always go prepared for lessons and spend time finding activities.” (PTF7)

Findings of the Features That Should Be Found in Games

The following features were determined in line with the opinions of the pre-service teachers on this theme.

Table 3. Theme 2- Features that Should be Found in Games

Features	Pre-Service Teachers Codes	Frequency
Suit to learning outcomes	PTM1, PTM2, PTM3, PTM5, PTM6, PTM11, PTF1, PTF2, PTF3, PTF4, PTF8, PTF9, PTF10, PTF13, PTF14	15
Being Suitable for grade level	PTM1, PTM2, PTM4, PTM11, PTF2, PTF4, PTF8, PTF10, PTF13	9
Being suitable for the cognitive development of the student	PTM1, PTM3, PTM5, PTM10, PTF3, PTF13	6
Love to mathematics	PTM1	1
Being suitable for student interest	PTM3	1
Being suitable for student skills	PTM3	1

In the scope of this theme, it was seen that the pre-service teachers mostly stated that the games should be suitable for the learning outcome. In addition, it was stated by many pre-service teachers that the games should be suitable for the class level and the cognitive development of the students. Additionally, it was determined that the games should make mathematics popular and should be suitable for students' interests and skills. The opinions of some pre-service teachers regarding this theme are given below.

“The most important thing is to design an example game suitable for the learning outcome.” (PTF3)

“Games and math learning outcomes should match grade levels. We need to specify is suitable for which learning outcome the game. For example, it would be wrong to play a game about factorization to 5th-grade students.” (PTF10)

“Games should be prepared by the age of the children. If it is not prepared according to the child's age and intelligence level, the child does not want to play the game and cannot achieve the learning outcome for which we aim.” (PTM3)

Findings of the Characteristics That Teachers Should Have

The following features were determined in line with the opinions of the pre-service teachers on this theme.

Table 4. Theme 3- Features that Teachers Should Have

Features	Pre-Service Teachers Codes	Frequency
Using different teaching methods	PTF7, PTF14	2
Have a high imagination	PTM5, PTF7	2
Ability to synthesize learning outcomes	PTM5	1
Ability to develop criteria	PTM5	1
Knowing the benefits and harms of the game	PTM1	1
Being able to interpret the learning outcomes	PTM5	1

When the table is examined, it is seen that it is emphasized that teachers should be able to use different teaching methods, have a high imagination, develop criteria, interpret and synthesize the learning outcomes, and know the benefits and harms of games. The opinions of some pre-service teachers regarding this theme are given below.

“The preparation of educational games requires a good imagination and synthesis ability.” (PTM5)

“It can sometimes be very difficult for teachers to be able to relate games and mathematics learning outcomes. The teacher needs to use his imagination at a high level to be effective on the learner, to attract the attention of the learner, and also to find games and activities that can be related to the learning outcomes.” (PTF7)

“To associate educational games with mathematics learning outcomes, first of all, we need to understand and interpret the learning outcomes of the secondary education program well.” (PTM1).

Findings of the Benefits of Games

In line with the opinions of the pre-service teachers, the benefits of the games were examined under two sub-themes: in terms of the development of the individual and terms of the lesson. The characteristics of the individual development sub-theme are given in the table below.

Table 5. Theme 4- Benefits of Games-In Terms of the Development of the Individual

Features	Pre-Service Teachers Codes	Frequency
Providing development	social PTM2, PTM5, PTM6, PTM7, PTF2, PTF3, PTF5, PTF6, PTF8, PTF9, PTF11, PTF13, PTF14	13
Developing reasoning	PTM1, PTM4, PTM6, PTM9, PTM10, PTM11, PTF2, PTF5, PTF9, PTF12	10
Enabling discovery	learning by PTM2, PTM6, PTM11, PTF1, PTF6, PTF7, PTF8, PTF10, PTF13	9
Enabling learning	cooperative PTM2, PTM4, PTM9, PTF2, PTF3, PTF8, PTF11, PTF14	8

Continue of Table 5

Features	Pre-Service Teachers Codes	Frequency
Cognitive development	PTM1, PTM2, PTM4, PTM7, PTM9, PTF2, PTF14	7
Developing the imagination	PTM8, PTF2, PTF3, PTF5, PTF8, PTF9, PTF13	7
Enabling strategic thinking	PTM1, PTM4, PTM6, PTM9, PTF13, PTF14	6
Ability to associate	PTF5, PTF9, PTF12, PTF13, PTF14	5
Increase self-confidence	PTM6, PTF2, PTF11, PTF14	4
Developing psychomotor skills	PTM2, PTF1, PTF3, PTF5	4
Providing affective development	PTM2, PTM5, PTF2, PTF5	4
Using technology	PTF5, PTF6, PTF8	3

When the table was examined, it was seen that the pre-service teachers stated that the games mostly provided the social development of the students. In addition, it was determined by the pre-service teachers that the games developed reasoning, imagination, and strategic thinking and that they provided discovery and collaborative learning. In addition, it has been determined that games increase self-confidence, develop psychomotor skills, and enable the use of technology. The opinions of some pre-service teachers regarding this theme are given below.

“Students learn tolerance, respect, and sharing while playing games. They feel happy. With educational games, they learn emotions such as friendship, love, and goodness.” (PTF8)

“When choosing an activity, it will be useful to encourage the student to explore, model, research, present evidence, and use technology.” (PTF6)

“It enables students to use symbols and terms that have meaningful relationships between them effectively and correctly.” (PTM10)

The features obtained by evaluating the benefits of the games in terms of the lesson are given in the table below.

Table 6. *Theme 4- Benefits of Games-In Terms of the Course*

Features	Pre-Service Teachers Codes	Frequency
Making the lesson fun	PTM2, PTM3, PTM4, PTM5, PTM6, PTM7, PTM8, PTM9, PTM10, PTM11, PTM12, PTF1, PTF2, PTF3, PTF5, PTF6, PTF8, PTF9, PTF10, PTF11, PTF12, PTF13	22
Increasing the permanence of knowledge	PTM2, PTM3, PTM5, PTM6, PTM10, PTF1, PTF2, PTF3, PTF4, PTF5, PTF6, PTF7, PTF8, PTF9, PTF12	15
Increasing interest in mathematics	PTM1, PTM3, PTM5, PTM6, PTM7, PTM9, PTM12, PTF1, PTF2, PTF4, PTF5, PTF7, PTF9, PTF14	14

Continue of Table 6

Features	Pre-Service Teachers Codes	Frequency
Providing learning from concrete to abstract	PTM4, PTM5, PTM7, PTM8, PTM9, PTM10, PTM11, PTF1, PTF2, PTF3, PTF6, PTF8, PTF10	14
Developing problem solving skills	PTM1, PTM5, PTM6, PTM9, PTM10, PTF2, PTF3, PTF5, PTF8, PTF9, PTF13	11
Associating with daily life	PTF2, PTF3, PTF4, PTF5, PTF6, PTF7, PTF8, PTF9, PTF10, PTF11, PTF12,	11
Increase motivation	PTM1, PTM2, PTM3, PTM4, PTM7, PTM9, PTM11, PTF2, PTF6, PTF11	10
Increasing active participation	PTM2, PTM3, PTM5, PTM10, PTM11, PTF1, PTF2, PTF7, PTF9, PTF11	10
Increasing the efficiency of teaching	PTM2, PTM7, PTM11, PTF5, PTF7, PTF11, PTF13, PTF14	8
Avoiding prejudice	PTM7, PTM9, PTF9, PTF10, PTF12, PTF13, PTF14	7
Reinforcing the topic	PTM1, PTM6, PTM8, PTM9, PTF2	5
Making learning easier	PTM2, PTM8, PTF4, PTF6	4
Being interdisciplinary	PTM10	1
Covering many learning outcomes	PTM9	1

When the table was examined, it was seen that the majority of the pre-service teachers stated that the games made the lesson fun. In addition, it was seen that pre-service teachers stated that games increase the permanence of knowledge, increase interest in mathematics, provide learning from concrete to abstract, improve problem solving skills, and relate it to daily life. Additionally, it was determined that some of the pre-service teachers stated that games increase motivation, ensure active participation in the lesson, reinforce the subject, and provide interdisciplinary learning. In this context, the opinions of some pre-service teachers are as follows.

“Playing and learning are two of the best things children do. Combining these two jobs and teaching with games is an application that is both fun and beneficial in learning. The main benefit of teaching mathematics with games is to save the student from a boring lesson while learning the subject and to embody the subject with applications.” (PTM7)

“It increases students' interest in mathematics. This enables students to give importance to mathematics and to deal with mathematics more.” (PTM1)

“Problem posing and solving skills are of great importance. At this point, educational games offer situations where students can create their problems, collect the necessary information for the solution and solve the problem.” (PTM5)

“It ensures that the child develops mentally and physically, gains good behavior, and reinforces the learned information.” (PTF2)

Findings of Negative Aspects of Games

In line with the findings obtained, the features given in the table below were determined for the negative aspects of the games.

Table 7. Theme 5- Negative Aspects of Games

Features	Pre-Service Teachers Codes	Frequency
Inconsistent with grade level	PTM1, PTM3, PTM6, PTF3, PTF7, PTF12	6
Confusing that it covers many learning outcomes	PTM5, PTM8, PTM11, PTF6, PTF10,	5
Disruption of course flow	PTM2, PTM6, PTM8, PTF8, PTF13	5
Unclear gains	PTM8, PTF4, PTF7, PTF12, PTF13	5
Turn into a habit	PTM9, PTF3, PTF5, PTF13	4
Dismissal from the lesson	PTM2, PTF3, PTF7	3
May cause health problems	PTF2, PTF13	2
Low motivation in case of failure	PTM2	1
Being not appeal to the area of interest	PTM3	1
Social life inhibition	PTF13	1

When the table was examined, it was seen that the pre-service teachers stated that the incompatibility of the games with the class level would create negativity. In addition, it has been determined that the fact that the games cover many acquisitions may cause confusion and the course flow may be disrupted. Additionally, health problems may occur, low motivation in case of failure, not appealing to students' interests, and hindering social life are among the features expressed. In this context, the opinions of some pre-service teachers are as follows.

“Let our game be a game that appeals to the 8th grade. If we give this to a 3rd grader, this game might make the student hate math.” (PTM1)

“Games can address more than one learning outcome. This may confuse the student. Therefore, the desired feedback from the student may not be obtained.” (PTM11)

“Since the games will take too long to be played, it can negatively affect the flow of the lesson.” (PTM2)

Findings of Implementation Problems

Negative situations that may arise during the implementation of the games are examined under the theme of application problems. The properties obtained in this context are given in the table below.

Table 8. Theme 6- Application Problems

Features	Pre-Service Teachers Codes	Frequency
Time shortage	PTM3, PTM4, PTM5, PTM6, PTM7, PTM9, PTM10, PTF1, PTF3, PTF4, PTF6, PTF8, PTF9, PTF10, PTF11	15
Excess cost	PTM5, PTM8, PTM11, PTF4, PTF6, PTF7, PTF8, PTF10	8
Not reusable	PTM5, PTF6, PTF8	3
Teacher's lack of authority	PTF6, PTF14	2
Lack of suitable environment	PTM6, PTF10	2
Lack of teacher support	PTM4, PTM11	2
Excess class size	PTM3, PTF9,	2
Regional variation	PTM5, PTF8	2
Disagreement between students	PTF10	1
Disagreement between students	PTM5	1

When the table is examined, it is stated that the most expressed feature by the pre-service teachers is that there may be a time problem during the implementation of the game. In addition, it was observed that the cost of the game, the inability to reuse the game, the lack of authority of the teacher, the lack of suitable environment, the excess of the class size were also stated. In this context, the opinions of some pre-service teachers are as follows.

"It is time-consuming. It may take a lesson for us to do this activity during the lesson. Therefore, activities should be planned to take this situation into account." (PTF4)

"The fact that the game to be used is costly and difficult to access can make it difficult to use in schools that have difficulties in terms of opportunities." (PTM8)

"Normally, it doesn't take long to explain a math topic. But gamifying that learning outcome takes time. Especially games played in crowded classrooms can waste a lot of time. For this reason, we may have difficulties in educating the curriculum subjects." (PTF9)

DISCUSSION AND CONCLUSION

This study was conducted to examine the opinions of pre-service mathematics teachers about the use of games in the learning and teaching process. In line with the findings, it was obtained as a result of examining the opinions of pre-service teachers on the use of games under 6 themes. These themes were determined as "game preparation process", "features that should be found in games", "features that teachers should have", "benefits of games", "negative aspects of games" and "implementation problems".

Within the scope of the theme of "Game Preparation Process", it was concluded that the pre-service teachers emphasized that the games should be suitable for the mathematics learning outcomes. In this direction, it is of great importance that pre-service teachers be aware of the learning outcomes in the curriculum and be aware of which games they

should associate with these learning outcomes. In addition, it was concluded that they thought that they should be careful and make effective planning during the game preparation process.

It was seen that the most emphasized feature of the pre-service teachers in the theme of "Features to be found in the games" was that the games prepared should be suitable for the determined learning outcomes. Here, it is concluded that besides being fun activities, the games should have features that can give the students gains. Supporting this result, there are various studies in the literature on the use of games based on achievements (Doğan & Sönmez, 2019; Özata & Coşkuntuncel, 2019; Proctor & Marks, 2013). On the other hand, it was stated by the pre-service teachers that the games should be appropriate for the grade levels, cognitive development, and interests of the students as well as being suitable for the learning outcomes. In addition to all these, it was also stated that the games should have features that will make students love mathematics by removing the prejudice against mathematics in society. In this way, it is thought that students will have spent the learning and teaching process both by having fun and by learning.

In line with the theme of "Characteristics That Teachers Should Have", it was determined that teachers should be able to use different teaching methods and have a high imagination to develop effective games. In this direction, it can be stated that interpreting the learning outcomes and realizing the relationships between each other, and forming games based on them will produce very effective results. In addition to all these, it was stated by the pre-service teachers that it is important to determine the positive and negative aspects of the games and apply them. In this way, it is thought that more effective lessons will be made.

The theme of "Benefits of Games" was examined within the scope of two sub-themes, namely the development of the individual and aspect of the course. When teaching with games is examined in terms of "individual development", it is basically concluded that it provides the social development of students. In this context, it has been determined that teaching with games increases self-confidence, provides cooperative learning and affective development. In this way, students can be improved in every way by participating in the learning process of games, which are very effective in carrying out students' social activities. In parallel, Veer (1996) stated that children learn many things from adults or peers through games. In addition, it was concluded that pre-service teachers stated that teaching with games was also very effective in the mental development of students. In this direction, it has been determined that games are effective in enabling the development of students' reasoning and imagination. In addition to these, it was concluded that it has a very important place in providing students' learning by discovery, cognitive development, and strategic thinking. Sanders (2016) and Kebritchi, Hirumi, and Bai (2010) also stated in their studies that math games are effective in improving students' thinking skills. In addition, it was determined that the pre-service teachers stated that the games were effective in improving the psychomotor skills of the students and enabling them to use technology. It is concluded that teaching with games in line with the specified features is an effective resource in ensuring that students develop not only in terms of their education but also in many ways individually. For this reason, it is thought that it will be important to use games in the learning-teaching process and to carry out effective studies on this subject.

When the theme of the "benefits of the games" is examined within the scope of the sub-theme "in terms of the lesson", first of all, it is concluded that it is effective in making the lessons fun. Studies have also determined that games are effective in transforming the lesson into a fun process (Berns, Gonzalez-Pardo, & Camacho, 2013; Hays, 2005; Heshmati, Kersting, & Sutton, 2018; Kaya & Elgün, 2015; Meletiou-Mavrotheris & Mavrotheris, 2012; Tural, 2005). It is thought that the use of games will eliminate this situation while it is expressed in the studies that mathematics lessons are difficult and boring (Dulkadir, 2017; Orim & Ekwueme, 2011). In addition, it was concluded that games were effective in developing problem-solving skills, providing teaching from concrete to abstract, increasing the permanence of knowledge, and ensuring active

participation in lessons. It has been observed that similar results have been obtained in the studies carried out (Altunay, 2004; Doğan & Sönmez, 2019; Özata & Coşkuntuncel, 2019; Romine, 2004). Similar to these results, Rutherford (2015) stated in his study that games are effective in applying mathematical knowledge. Cahyono (2018) and Machaba (2019) stated in their studies that games increase class participation. At the same time, it has been determined that games have an important place not only in mathematics but also in connecting with other lessons and in associating them with daily life. In addition, it was stated by the pre-service teachers that it is important to use games to increase students' motivation, increase interest in mathematics, and prevent prejudice against mathematics. Similar results are also available in the studies carried out (Festus & Adeyeye, 2012; Heshmati, Kersting, & Sutton, 2018; Larkin & Nigel, 2016; Özata & Coşkuntuncel, 2019). These features can be expressed as that the use of games will be effective not only in the scope of the course but also in the elimination of negative attitudes towards mathematics by associating mathematics subjects with daily life.

In the theme of "Negative Aspects of Games", it was concluded that the use of games in the teaching process may cause confusion in the minds of students as a result of the fact that the games are not determined according to the appropriate grade levels, they cover many achievements and the determined achievements are not clear. For this reason, it is thought that paying attention to these situations while determining the games is important in using the games more effectively. Similarly, it has been determined that the use of games in the classroom environment can negatively affect the course flow. In this direction, it is thought that it will be important to carefully plan the lessons in which games will be played. In case of failure in the games, it was stated by the pre-service teachers that there might be low motivation in the students. In addition, it was concluded that it was emphasized that the games could cause students to move away from the lesson, as they turned into a habit in students. Similar to this situation, some studies have also found that spending too much time on games can reduce math achievement (Huang & Ke, 2009; Swearingen, 2011). It is also emphasized that playing individual games too much will prevent students from social life and cause health problems. Considering all these situations, it is thought that the teaching process is necessary for an effective lesson.

In the theme of "Application Problems", it was concluded that the situation that the pre-service teachers basically stated may create a time problem due to a limited time during the course, and therefore there may be a problem in practice. It has been stated by the pre-service teachers that it can be difficult to practice game activities in crowded classrooms. Such statements were also found in the results of various studies (Ke, 2013; Kebritchi, Hirumi, & Bai, 2010). In addition, it was concluded that the teachers thought that they should pay attention to the conflicts, and that may occur in ensuring the coordination between the students during the implementation of the games. Similarly, Güneş (2010) concluded in his study that teaching with games can create practice problems in terms of time constraints and student control. In addition, it was concluded that it was emphasized by the students that waiting for the games to be done every lesson can cause problems in the processing of other subjects.

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