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# Middle School Mathematics Teachers' Views on The Concept of Mathematical Game[1]

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**Abstract**

In this study, the views of middle school mathematics teachers on the concept of mathematical games were investigated. The participants of the study consisted of 13 middle school mathematics teachers. Phenomenology, one of the qualitative research methods, was used in the study. Interviews were used for the collection of data. The data were analyzed through content analysis. As a result of the research, the teachers mostly used the expressions instructive and fun in their definitions of mathematical games. It was found that the participants explained the relationship between mathematics and games with the presence of mathematics in games and mathematics making sense of games. It was observed that teachers used mathematical games for cognitive/academic and affective purposes. In terms of the benefits of mathematical games, the focus was on the benefits for the subject, the student and the teacher. Similarly, it was emphasized that mathematical games have various effects on students' learning, attitudes toward the lesson, personal development and social development. However, it was determined that teachers experienced various difficulties during the game design/planning and teaching process.

**Keywords:** mathematics, game, educational game, mathematical game.

**Ortaokul Matematik Öğretmenlerinin Matematiksel Oyun Kavramına İlişkin Görüşleri**

**Özet**

Bu araştırmada ortaokul matematik öğretmenlerinin matematiksel oyun kavramına ilişkin görüşleri araştırılmıştır. Çalışmanın katılımcıları 13 ortaokul matematik öğretmeninden oluşmaktadır. Araştırmada nitel araştırma yöntemlerinden fenomenoloji kullanılmıştır. Veri toplamada mülakatlar kullanılmıştır. Veriler içerik analizi ile analiz edilmiştir. Araştırma sonucunda öğretmenlerin matematiksel oyun tanımlamalarında en çok öğretici ve eğlenceli ifadelerini kullandıkları görülmüştür. Katılımcıların matematik ve oyun arasındaki ilişkiyi oyunlarda matematiğin varlığı ve matematiğin oyunları anlamlandırması ile açıkladıkları görülmüştür. Öğretmenlerin matematiksel oyunları, bilişsel/akademik ve duyuşsal amaçlar doğrultusunda kullandıkları görülmüştür. Matematiksel oyunların faydaları konusunda ise konuya, öğrenciye ve öğretmene yönelik faydalara odaklanılmıştır. Benzer şekilde matematiksel oyunların öğrencilerin öğrenme durumlarına, derse yönelik tutumlarına, kişisel gelişimlerine ve sosyal gelişimlerine çeşitli etkilerinin olduğu vurgulanmıştır. Bununla birlikte, öğretmenlerin oyun tasarlama/planlama ve ders sürecinde çeşitli zorluklar yaşadıkları tespit edilmiştir.

**Anahtar Kelimeler:** matematik, oyun, eğitsel oyun, matematiksel oyun.

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## Introduction

Mathematics has been a feared and unsuccessful subject for many students. While anxiety is one of the common problems today, tests and exams in education also cause mathematics anxiety (Luttenberger et al., 2018). Tuncer and Yılmaz (2016) stated that achievement anxiety causes students to have a negative attitude toward mathematics. There are also many studies investigating the relationship between mathematics anxiety and mathematics achievement (Ramirez et al., 2018; Weissgerber et al., 2022; Zhang et al., 2019). Zivkovic et al. (2023) found that there was a negative relationship between students' enjoyment of mathematics and mathematics anxiety. Students see mathematics as numbers and calculation and think that they need to be smart to be successful in mathematics (Uçar, 2011). The idea that one can be successful in mathematics with innate talent is seen as one of the causes of mathematics anxiety (Delice et al., 2009). While students' study time and study methods have a positive effect on their achievement, there is a significant relationship between achievement and attitude toward mathematics (Uçar et al., 2010). It can be said that involving students in the lesson will increase their self-confidence and thus reduce anxiety (Baas, 2020). In addition to focusing on meaningful learning and a student-centered approach in the mathematics learning and teaching process, revealing the fun aspect of mathematics through the use of activities, concrete materials and games should be considered in developing positive attitudes toward mathematics (Topbaş Tat, 2021).

Games have been around in various forms since humans have existed. Games, which are an important part of childhood, are effective in developing problem solving skills in a creative way (Broadhead, 2006; Wood, 2009). There are 5 main reasons why people play games. These reasons are relationship, desire to participate, emotional conflict arising from competition, success and leadership (Yee, 2002, as cited in Uğurel & Moralı, 2008). According to Uğurel and Moralı (2008), the relationship between mathematics and games can be explained by associating the desire to solve mathematical problems with these reasons. Beyond the relationship between mathematics and games, games have become an alternative method in mathematics teaching today. In addition to reducing mathematics anxiety, games, especially computer games, have a very important place in learning abstract mathematical concepts (Demirbilek & Tamer, 2010). In addition, the use of games is important for increasing achievement in mathematics and for having a positive effect on the perception of and attitudes toward mathematics in society (Fajri, 2020; Uğurel & Moralı, 2008). Çakıroğlu and Baki (2016) emphasized that the use of learning objects in mathematics teaching has a positive effect on the attitude toward mathematics, but emphasized the importance of combining the objects used especially with game and competition style activities. Teaching with games can also be seen as a way of learning mathematics through experiences (Weng, 2022). With mathematical games, students become more active in the classroom and have the opportunity to succeed (Rawansyah et al., 2021; Tural Sönmez, 2012). Teaching with games increases participation while supporting creative learning and problem solving (Smith, 2020). In summary, it can be stated that mathematical games provide both cognitive and affective benefits (Alanazi, 2020; Arroyo et al, 2017; Bullock et al., 2021; Fouze & Amit 2018; Kiili et al., 2014; Maryani, 2019; Moyer et al., 2019).

When the studies on mathematical games are examined, it is generally seen that experimental studies were conducted to determine the effect of the game on various variables such as achievement, motivation and attitude (Başün & Doğan, 2020; Canbay, 2012; Cohrssen & Niklas, 2019; Denli, 2021; Fiorella et al., 2019; Ihendinihu, 2020; Ku et al., 2014; Muntean et al., 2018). In addition, systematic review studies on mathematical games were also found in the literature (Pan et al, 2022; Uluçay and Çakır, 2014). There are also descriptive studies in which we can see the opinions about mathematical games. For example, Ayvaz Can (2020)

found that mathematical game perceptions of prospective primary school teachers were positive. In the studies on teachers' perceptions and use of mathematical games, it can be seen that most of the studies have been conducted with primary school teachers (Ateş & Bozkurt, 2021; Çil & Sefer, 2021; Doğan & Sönmez, 2019; Hoşgör, 2010). However, there are also studies conducted with mathematics teachers and prospective teachers (Özata, 2019; Yıldız Durak, 2020). When analyzing the participants in the studies on mathematical games, it is found that these studies were mostly conducted with students and prospective teachers. In various studies conducted with teachers and prospective teachers, participants' game design and implementation processes were analyzed (Karadeniz, 2017; Topçu et al., 2014; Ünveren Bilgiç, 2021). In these studies, teachers were asked to design a game and this process was analyzed. In the studies on the applicability of mathematical games, the opinions of teachers and prospective teachers were taken through the games determined (Doğan Sönmez, 2019; Hoşgör, 2010; Özata, 2019). Studies on teachers and prospective teachers, who are the group that both implement and design games, are important in terms of reflecting their perspectives on the concept of mathematical games. In addition, teachers' opinions are important in terms of reflecting experiences on many issues such as the effectiveness of mathematical games, students' reactions to mathematical games, and the difficulties encountered in using mathematical games. However, it has been observed that there are few studies in the literature where we can see the views of middle school mathematics teachers on this issue. Accordingly, the aim of this study is to determine the views of middle school mathematics teachers working in schools affiliated to the Republic of Türkiye Ministry of National Education on the concept of mathematical games. The problem statement of the study was determined as "What are the views of middle school mathematics teachers on the concept of mathematical game?". The sub-problems of the study are as follows:

1) How do middle school mathematics teachers define mathematical game?
2) What are the views of middle school mathematics teachers on the relationship between the concepts of mathematics and game?
3) What is the status of middle school mathematics teachers' use of mathematical games?
4) What are the views of middle school mathematics teachers on the purposes of using mathematical games?
5) What are the views of middle school mathematics teachers on the features that should be included in mathematical games?
6) What are the views of middle school mathematics teachers on the benefits of using mathematical games in mathematics teaching?
7) What are the views of middle school mathematics teachers on the difficulties in the use of mathematical games?
8) What are the views of middle school mathematics teachers on students' reactions to mathematical games?
9) What are the views of middle school mathematics teachers on the effects of using mathematical games on students?
10) What are the suggestions of middle school mathematics teachers about mathematical games and the use of mathematical games?

## Method

Qualitative research method was used in this study. The aim of qualitative research is in-depth description and interpretation. Qualitative researchers report different perspectives and many factors related to the problem and ultimately reveal the big picture in general (Creswell, 2013). Phenomenology, one of the qualitative research designs, was used in the study. Phenomenology is an in-depth research that allows us to fully grasp the phenomena. As a

result of the research, a better understanding of the phenomenon is achieved. In phenomenology, research is conducted with individuals who experience the phenomenon (Yıldırım & Şimşek, 2021). Phenomenology deals with lived experiences. The personal experiences of the participants are emphasized. The essence of the experiences is discussed. A common definition made by the participants is discussed (Creswell, 2013). In this study, phenomenology was used since it was aimed to learn the views of middle school mathematics teachers on the concept of mathematical game.

### *Participants*

Participants of the study consists of middle school mathematics teachers working in public schools affiliated to the Republic of Türkiye Ministry of National Education. The study was carried out with 13 mathematics teachers working in Karapınar district of Konya province. The teachers participating in the study were determined on a voluntary basis. For ethical reasons, the names of the participants and the schools where they work were kept confidential. Accordingly, the participants were referred to as T1, T2, T3, ..., T13. Information on gender, age and teaching experience of the participants is given in Table 1.

**Table 1.** Information on gender, age and teaching experience of the participants

| Code | Gender | Age | Teaching experience |
|---|---|---|---|
| T1 | Female | 25 | 4 |
| T2 | Female | 31 | 10 |
| T3 | Female | 32 | 4 |
| T4 | Male | 36 | 14 |
| T5 | Female | 27 | 5 |
| T6 | Female | 27 | 4 |
| T7 | Female | 29 | 3 |
| T8 | Female | 30 | 9 |
| T9 | Female | 26 | 4 |
| T10 | Male | 29 | 5 |
| T11 | Female | 28 | 5 |
| T12 | Female | 37 | 15 |
| T13 | Female | 27 | 4 |

### *Data collection*

Interview method was used to collect data in the study. Interview is the most frequently used data collection method in qualitative research. Since the interview is based on speaking, it is a method that eliminates limitations in data collection (Yıldırım & Şimşek, 2021). The semi-structured interview form developed by the researcher was used as a data collection tool in the study. In semi-structured interviews, the participant is asked open-ended questions that are not predetermined, in addition to predetermined questions. Semi-structured interviews are more suitable for qualitative research as open-ended questions eliminate limitations (Çelebi, 2021). The interview form developed in this context consists of two parts. The first part consists of 10 questions about the personal information of the participants, and the second part consists of 11 questions about the concept of mathematical games. Teachers were asked questions about the definition of mathematical games, the relationship between mathematics and games, their use of mathematical games, the games they use, the features that mathematical games should have, the benefits of mathematical games, the difficulties in using games, students' reactions to games, and the effects of games on students.

Interviews were conducted with the identified participants by determining the time when the participants were available. The interviews were conducted in the schools where the participants were working. The interviews lasted between 10-30 minutes. During the interviews, voice recordings were taken with the consent of the participants.

### *Data analysis*

The data collected in the study were analyzed by content analysis. In content analysis, data are analyzed in more depth. It is analyzed with themes that are not predetermined. The list of codes and themes can be changed and developed (Yıldırım & Şimşek, 2021). Content analysis mostly deals with how and why question patterns (Çelebi, 2021). During the data analysis process, firstly the interviews were transcribed. Then, codings were made and themes were developed. The themes and codes were presented in the findings section with frequency values and tables for each sub-problem.

### *Validity and reliability*

In qualitative research, validity and reliability are ensured by reporting the data obtained in detail, including direct details, obtaining expert opinion, and explaining the data collection and data analysis in detail (Yıldırım & Şimşek, 2021). Ethics committee permission was obtained before the study. The interview form used in the research was prepared by taking expert opinion. Before the actual interviews, a pilot interview was conducted with a middle school mathematics teacher other than the participants of the study. The data collected in the study were firstly written down. The codings were reported in detail. In addition, direct quotations from the interviews were also included in the findings section. Data collection and data analysis were explained in detail.

## Findings

In the study, answers to 10 sub-problems were sought to investigate the views of middle school mathematics teachers on the concept of mathematical game. The findings were presented according to the sub-problems. The findings are presented in tables with frequency values.

### *Middle School Mathematics Teachers' Definitions of Mathematical Games*

The findings related to the first sub-problem of the study, “How do middle school mathematics teachers define mathematical games?” are given in Table 2. Teachers' definitions of mathematical games were grouped under three themes: cognitive/academic dimension, affective dimension and content dimension.

**Table 2.** Middle school mathematics teachers' definitions of mathematical games

| Theme | Code | *f* | Participant |
|---|---|---|---|
| Cognitive/Academic Dimension | Instructive | 7 | T1, T3, T5, T7, T8, T10, T11 |
| | Concretizing | 2 | T5, T11 |
| | Active participant | 1 | T9 |
| Affective Dimension | Entertaining | 6 | T1, T3, T7, T8, T9, T10 |
| | Intriguing | 1 | T5 |
| | Endearing mathematics | 2 | T4, T6 |
| Content Dimension | Connected to everyday life | 2 | T10, T12 |
| | Involving mathematical operation/mathematics | 1 | T13 |
| | Involving the history of mathematics | 1 | T2 |

| | | |
|---|---|---|
| Involving drama | 1 | T2 |

According to Table 2, teachers defined mathematical games as instructive, concretizing and enabling active participation in the cognitive/academic dimension. In the affective dimension, they defined it as entertaining, intriguing and endearing mathematics. In the content dimension, they defined mathematical games as being connected to everydaily life, involving mathematical operations/mathematics, involving the history of mathematics, and involving drama. In the definitions, the instructive aspect of the mathematical game was emphasized with expressions such as understanding, comprehension and learning. For example, T1 defined mathematical games as; "Games that we use in the lesson, that we make students play so that they can better understand and comprehend the subject and that we use to make the lesson more fun". While defining the mathematical game, T6 said; "I think mathematical game is an application that we do to make students love mathematics and I think that everything we do in this field can be included in the concept of mathematical game".

### *Middle School Mathematics Teachers' Views on the Relationship between Mathematics and Game*

The second sub-problem of this study is "What are the views of middle school mathematics teachers on the relationship between the concepts of mathematics and game?". The findings of middle school mathematics teachers' views on the relationship between mathematics and game are presented in Table 3.

**Table 3.** The relationship between mathematics and game

| **Code** | ***f*** | **Participant** |
|---|---|---|
| There is mathematics in games | 13 | T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13 |
| Math makes sense of the game | 2 | T5, T7 |

According to Table 3, the teachers expressed the relationship between the concepts of mathematics and games as follows: *There is mathematics in games and mathematics makes sense of games*. T8, who stated that there is mathematics in games, explained this situation as follows:

> *Of course there is maths in games. We already start with the simplest hopscotch at the very beginning, don't we? We can say that the child encounters the most numbers. Apart from that, I think it is present in all games. For example, the child counts, basic counting skills, for example, she will play hide and seek, maybe counting starts at the age of five... I think it is also present in the games that children play in their social life.*

Teachers associated the mathematics in the games with the game rules. T9 stated that mathematics was used while creating game rules; "Games are related to mathematics. We definitely benefit from mathematics when creating games or rules". T13 stated that there is mathematics in the rules of games as follows: "We can say that there is mathematical thinking in the formation and rules of games".

### *Middle School Mathematics Teachers' Use of Mathematical Games*

The findings related to the third sub-problem of the study, "What is the status of middle school mathematics teachers' use of mathematical games?" are presented in Table 4. All teachers participating in the study stated that they used games. Accordingly, the status of middle school mathematics teachers' use of mathematical games was categorized under the themes of the games used, frequency of game use, the phase of the lesson used, and the grade level used.

**Table 4.** The status of middle school mathematics teachers' use of mathematical games

| Theme | Code | *f* | Participant |
|---|---|---|---|
| Games Used | Paper and pencil games | 9 | T1, T3, T5, T6, T7, T8, T9, T11, T12 |
| | Digital games | 9 | T4, T5, T6, T7, T8, T9, T10, T12, T13 |
| | Physical games | 2 | T2, T11 |
| Frequency of game use | Not very often | 12 | T1, T2, T3, T4, T5, T6, T7, T9, T10, T11, T12, T13 |
| | Every week | 1 | T8 |
| The phase of the lesson used | All stages | 3 | T4, T10, T12 |
| | End of lesson/subject | 8 | T2, T3, T5, T6, T7, T9, T11, T13 |
| | Reinforcing the topic | 3 | T1, T8, T13 |
| | Evaluation | 1 | T13 |
| Grade level used | Grade 5 | 13 | T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13 |
| | Grade 6 | 10 | T1, T3, T4, T5, T7, T10, T11, T12, T13 |
| | Grade 7 | 6 | T1, T5, T6, T11, T12, T13 |
| | Grade 8 | 5 | T1, T5, T6, T11, T12 |

According to Table 4, the games used by the teachers were coded as *paper and pencil games*, *digital games* and *physical games*. T7, who stated that she used paper and pencil games and digital games, said: "I used puzzles. Also, when I turn them into competitions, children are more interested in them. There are also smart boards, interactive games, especially in integers, we also used them". T1 stated that there were also coloring activities in the games she used. Coloring activities were coded as paper and pencil games. Among the teachers who use digital games, T6 explained the games she used as follows: "We actually play games on the smart board more. We use various applications or use games on EBA (Educational Informatics Network)". T11, one of the teachers who used physical games, explained the game as follows:

> *On a ground drawn on the ground in the coordinate system; we made games in which we determined the positions of the children and determined their positions relative to each other. In eigth grades, we played games about the position of the point relative to the point, their location on the coordinate system.*

According to Table 4, teachers' frequency of game use was coded as *not very often* and *every week.* When the frequency of teachers' game use was analyzed, 12 teachers stated that they did not use games very often. One teacher stated that she used games every week. T3 stated that she did not use games very often and expressed her thoughts as follows: "I cannot use them very often. Naturally, since our class hours are limited, in order to catch up with the subjects". T3 associated this situation with the difficulty she had in allocating time. Similarly, T9, while associating the fact that she did not use games very often with time and curriculum, expressed her thoughts as follows: "Unfortunately, I cannot use it very much because the course duration and curriculum are intense".

According to Table 4, the stages of the lesson in which mathematical games were used were coded as *all stages, end of lesson/topic, reinforcing the topic and evaluation.* T1, explaining

the use of games at the end of the subject with the reason that there should be no confusion, expressed her views as follows: “I prefer to use the game after giving the basic rules of the topic first, so that they can understand it better. I do not prefer it at first in order not to be confusing”.

According to Table 4, the status of middle school mathematics teachers' use of mathematical games by grade level was coded as 5th grade, 6th grade, 7th grade and 8th grade. According to Table 4, games were used in all grade levels. It is also seen that teachers mostly preferred to use games at the 5th grade level. Explaining this situation with the fact that 5th grade students are at the age of play, T9 expressed her views as follows: “I use it more in fifth grade. Since fifth graders are at the age of play and the subjects are more suitable for games, I prefer this age group more”.

### *Middle School Mathematics Teachers' Purposes of Using Mathematical Games*

The findings related to the fourth sub-problem of the study, “What are the views of middle school mathematics teachers on the purposes of using mathematical games?” are given in Table 5. Teachers' purposes of using mathematical games were divided into two as *cognitive/academic purposes* and *affective purposes*.

**Table 5.** Middle school mathematics teachers' purposes of using mathematical games

| Theme | Code | *f* | Participant |
|---|---|---|---|
| Cognitive/Academic purposes | Teaching the subject | 2 | T1, T8, |
| | Reinforcing the topic | 6 | T3, T5, T6, T7, T8, T11 |
| | Ensuring understanding/comprehension | 5 | T5, T7, T10, T11, T13 |
| | Ensuring active participation | 10 | T1, T3, T4, T5, T6, T7, T8, T9, T10, T13 |
| | Conducting measurement/evaluation | 2 | T2, T3 |
| | Concretizing | 5 | T7, T8, T11, T12, T13 |
| | Making the lesson effective | 3 | T3, T4, T9 |
| | Associating with daily life | 3 | T2, T12, T13 |
| Affective Purposes | Endearing mathematics | 3 | T2, T4, T9 |
| | Changing the perception that math is difficult | 2 | T3, T8 |
| | Providing motivation | 1 | T1 |
| | Making the lesson fun | 8 | T1, T2, T3, T5, T7, T8, T9, T13 |
| | Attracting interest | 6 | T1, T5, T6, T7, T9, T13 |
| | Ensuring adaptation to school/lesson | 2 | T3, T8 |

According to Table 5, teachers' cognitive/academic purposes for using mathematical games were coded as *teaching the subject, reinforcing the topic, ensuring understanding/comprehension, ensuring active participation, conducting measurement/evaluation, concretizing, making the lesson effective and associating with daily life*. In the affective dimension, it was coded as *endearing mathematics, changing the perception that mathematics is difficult, providing motivation, making the lesson fun, attracting interest, and ensuring adaptation to school/lesson.* However, teachers stated that they used mathematical games for more than one reason. For example, T3 stated that the purposes of using mathematical games were to ensure active participation, to make the lesson

effective, to make the lesson fun, to change the perception that mathematics is difficult, and to adapt to the school/lesson:

> *What are the purposes of use? As I said, to make the lesson more effective, to make the students who do not participate in the lesson participate in the lesson... I want to break the perception that mathematics is difficult, in fact, mostly for this... I try to make the lesson more fun so that they can adapt to middle school better or not to create a perception that mathematics is difficult.*

### *Characteristics of Mathematical Games According to Middle School Mathematics Teachers*

The findings related to the fifth sub-problem of the study, "What are the views of middle school mathematics teachers on the features that should be included in mathematical games?" are given in Table 6. As a result of the analysis of the data, the features that should be present in mathematical games consist of the themes of *the contributions of games to the learning and teaching process, game content, game duration and participant status of the games.*

**Table 6.** Characteristics of mathematical games

| **Theme** | **Code** | ***f*** | **Participant** |
|---|---|---|---|
| Contributions to the teaching and learning process | Motivating | 2 | T1, T5 |
| | Intriguing | 7 | T1, T2, T4, T7, T9, T12, T13 |
| | Communication enhancing | 3 | T2, T6, T8 |
| | Collaborative | 1 | T3 |
| | Educational | 1 | T5 |
| | Instructive | 3 | T3, T5, T11 |
| | Entertaining | 4 | T3, T4, T7, T9 |
| Game content | Containing drama | 1 | T2 |
| | Containing the history of mathematics | 1 | T2 |
| | Appropriate to the Curriculum | 6 | T2, T4, T9, T11, T12, T13 |
| | Suitable for student level | 4 | T2, T4, T5, T10 |
| | Up-to-date | 1 | T12 |
| | Understandable | 4 | T1, T6, T8, T10 |
| | Easy to apply | 3 | T7, T10, T13 |
| | Safe | 1 | T4 |
| | Economic | 2 | T4, T13 |
| Game duration | Two class hours | 3 | T2, T4, T11 |
| | One class hours | 6 | T3, T6, T7, T8, T9, T13 |
| | Less than one class hour | 2 | T5, T10 |
| | Variable depending on the student | 2 | T1, T12 |
| Participant Status | Group games | 6 | T1, T2, T5, T6, T8, T11 |
| | Individual games | 2 | T12, T13 |
| | Individual-Group games | 5 | T3, T4, T7, T9, T10 |

According to Table 6, the features that mathematical games should have were coded in terms of their contribution to the learning and teaching process as *motivating, intriguing, communication enhancing, collaborative, educational, instructive and entertaining*.

Emphasizing that the games should be intriguing and entertaining, T7 expressed her thoughts as follows: “It should first attract the attention of the class. Children should focus on it, we can say that it should be intriguing. Then it can be entertaining. It can be entertaining for children to be more active in an activity...”. In addition, T7 stated that entertaining games would increase participation.

According to Table 5, the content of the games were coded as *including drama, including the history of mathematics, appropriate to the curriculum, appropriate to the student level, up-to-date, understandable, easy to apply, safe and economic*. For example, T5 emphasized that mathematical games should be suitable for the level of students, motivating and instructive and stated the features that should be in mathematical games as follows: “It is important that it is suitable for students' readiness and developmental levels. It is also important that it is instructive and educational... I think it should also increase motivation”.

According to Table 6, the duration of mathematical games was coded as *two class hours, one class hour, less than one class hour and variable depending on the student*. According to Table 5, teachers mostly stated that the duration of mathematical games should be one class hour. Associating the time allocated for the mathematical game with the attention of the students, T6 expressed her thoughts as follows:

> *Unfortunately, it cannot be short because it is not possible to keep the concentration of the class. So it takes a little longer. I don't think less than one lesson is appropriate. I think at least 40 minutes will go because there is an explanation period and it takes a long time for the children to adapt.*

T5, on the other hand, stated that the duration should be less than one class hour in order not to distract the attention of the students: “It cannot be too long anyway, and I think it should be about 20-30 minutes in a way that will not bore the students and will not disturb their attention”.

According to Table 5, the participant status of mathematical games was coded *as group games, individual games and individual-group games*. T2 discussed the increase in communication in group games and said: “It would be better with a group, I think it would be more efficient. Group game is better both for the communication of the students and for it to be more fun”. T4 expressed his views “I think both group and individual games should be used according to the time and place, I use them”. Referring to the advantage of observing students individually in individual games, T13 expressed her views as follows: “The games on the smart board that I implement are usually individual. I like it. The students see themselves individually, I see them. This is an advantageous situation, of course”.

### *Benefits of Using Mathematical Games According to Middle School Mathematics Teachers*

The findings related to the sixth sub-problem of the study, “What are the views of middle school mathematics teachers on the benefits of using mathematical games in mathematics teaching?” are given in Table 7. The benefits of using mathematical games according to middle school mathematics teachers are presented under the themes of *benefits for the subject, benefits for the student and benefits for the teacher.*

**Table 7.** Benefits of using mathematical games

| Theme | Code | *f* | Participant |
|---|---|---|---|
| Benefits for the subject | Associates with daily life | 2 | T11, T12 |
| | Concretizes | 2 | T4, T12 |
| | Provides easy learning | 5 | T1, T7, T8, T11, T12 |
| | Provides permanent learning | 5 | T4, T5, T7, T8, T11 |

| | | | |
|---|---|---|---|
| Benefits for the student | Enables understanding/comprehension | 6 | T2, T3, T9, T10, T11, T13 |
| | Provides practicality | 1 | T12 |
| | Provides active participation | 10 | T2, T3, T 4, T5, T6, T7, T9, T10, T11, T12 |
| | Enables peer learning | 5 | T2, T6, T7, T8, T9 |
| | Supports the development of intelligence | 1 | T2 |
| | Provides self-assessment | 2 | T9, T13 |
| | Provides effective lesson | 3 | T2, T5, T9 |
| | Increases communication | 4 | T3, T6, T8, T13 |
| | Provides adaptation to school | 1 | T6 |
| | Develops a positive attitude | 5 | T5, T8, T11, T12, T13 |
| | Increases interest | 2 | T1, T5 |
| | Provides motivation | 4 | T1, T5, T10, T12 |
| | Reduces fear | 3 | T1, T2, T3 |
| | Makes the lesson fun | 10 | T1, T3, T4, T5, T7, T8, T9, T11, T12, T13 |
| | Provides a sense of achievement | 2 | T4, T8 |
| Benefits for the Teacher | Facilitates observation | 5 | T1, T3, T8, T12, T13 |
| | Facilitates evaluation | 1 | T1 |
| | Improves time management | 3 | T1, T2, T4 |
| | Provides positive feedback | 1 | T13 |
| | Enables student-teacher communication | 2 | T2, T3 |
| | Provides motivation | 1 | T9 |
| | Makes the lesson fun | 1 | T12 |

According to Table 7, the benefits of mathematical games for the subject were coded as *associates with daily life and concretizes*. T11 expressed her thoughts as follows: "Our games can benefit the use of what they have learned in daily life". She stated that mathematical games are useful for associating learnings with daily life.

According to Table 7, the benefits of mathematical games for students were coded *as provides easy learning, provides permanent learning, enables understanding/comprehension, provides practicality, provides active participation, enables peer learning, supports the development of intelligence, provides self-assessment, provides effective lesson, increases communication, provides adaptation to school, develops positive attitudes, increases interest, provides motivation, reduces fear, makes the lesson fun and provides a sense of achievement*. T7 explained the benefits of mathematical games for students as follows:

> *First of all, it increases permanent learning. I think what we tell will become more permanent. These types of games take place in their memories. So I think we can say that it increases permanent learning... We can also say that it facilitates learning... I can say that it is both permanent and facilitates learning.*

T1, who thinks that mathematical games reduce the fear of mathematics and develop a positive attitude toward mathematics with the ease of learning and the benefits they provide to the subject, explained her thoughts as follows:

> *I think it makes learning easier for the student. The student's interest in mathematics may increase and the fear may decrease. For example, if the student realizes that the game make the subject easier or, for example, in mathematics, we usually cannot use what we learn in daily life, we think, what use is it to us, but if the students see a place*

*to apply it in the game, maybe it can make them more motivated. Of course, this can vary from subject to subject.*

According to Table 7, the benefits of mathematical games for teachers were coded as *facilitates observation, facilitates evaluation, improves time management, provides positive feedback, enables student-teacher communication, provides motivation, and makes the lesson fun*. T1 who stated that mathematical games provide convenience for the teacher and that the increased communication in the classroom environment provides ease of observation for the teacher also explained views as: "Especially in individual activities, you have the opportunity to follow students individually. In terms of developmental follow-up, I think it is good".

### *Difficulties in the Use of Mathematical Games According to Middle School Mathematics Teachers*

The findings related to the seventh sub-problem of the study, "What are the views of middle school mathematics teachers on the difficulties in the use of mathematical games?" are given in Table 8. The difficulties encountered in the use of mathematical games were categorized under two themes: *difficulties encountered in the game design/planning process and difficulties experienced during the lesson.*

**Table 8.** Difficulties in the use of mathematical games

| Theme | Code | *f* | Participant |
|---|---|---|---|
| Difficulties encountered in the game design/planning process | Designing appropriate games | 2 | T3, T6 |
| | Concretizing | 1 | T12 |
| | Designing intriguing games | 1 | T1 |
| | Not being able to predict student reactions | 1 | T2 |
| | Adjusting the game duration | 1 | T1 |
| | Finding appropriate games | 5 | T5, T7, T8, T9, T13 |
| | Accessing resources | 1 | T7 |
| | Requiring labor | 4 | T2, T5, T9, T13 |
| | Requiring cost | 2 | T4, T6 |
| | Allocating time | 11 | T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13 |
| Difficulties experienced during the lesson | Explaining/teaching the rules of the game | 5 | T1, T5, T6, T8, T10 |
| | Ensuring concentration | 1 | T6 |
| | Game management | 10 | T3, T5, T6, T7, T8, T9, T10, T11, T12, T13 |
| | Making the lesson flow difficult | 1 | T1 |

According to Table 8, the difficulties experienced by teachers in the process of designing/planning games were coded as *designing appropriate games, concretizing, designing intriguing games, not being able to predict student reactions, adjusting the game duration, finding appropriate games, accessing resources, requiring labor, requiring cost, and allocating time*. The difficulties experienced during the lesson process were coded as *explaining/teaching the rules of the game, ensuring concentration, game management and making the lesson flow difficult*. While T10 emphasized the process required to prepare the game, he expressed his thoughts as follows: "In the games we use, preparing the material requires a process. We cannot say I will play a game with zero preparation. We cannot teach a lesson with zero preparation anyway. It has difficulties in this way, but as I said, after a while...". T9, who had difficulty in finding appropriate games in the game design/planning

process, associated this situation with the curriculum and grade levels and said: “It is also very difficult to find appropriate games. At every grade level, it can be impossible to complete the curriculum on time and make the lesson fun with games suitable for the curriculum. Sometimes, I think it is actually a challenging process in general, it requires labor and a lot of time”.

According to Table 8, teachers stated that they had more difficulty in game management (f=10) during the lesson. Associating the difficulty in game management with the class size, T3 expressed her thoughts as follows: “I think this is the most difficult part if the class is crowded, controlling the class. It is much more difficult than teaching a normal lesson, the noise can be too much”. Similar thoughts were expressed by T12; “We can lose control of the class, there can be a lot of noise. When there is a lot of noise, we may have difficulty in following the development of the students”.

According to Table 8, another difficulty experienced during the lesson process was stated as explaining/teaching the game rules. T1 stated that explaining/teaching the game may cause confusion in the students and explained this situation as follows:

> *The most difficult situations for me are explaining and teaching the rules of the games to the students, because most of the time the students have difficulty in understanding. Because at the beginning, students come to us with a prejudice, they have difficulty in mathematics. We explain the subject, and when we give the rules of the game to the students, if these rules are a bit complicated, the students may break away, that is, they may have difficulty.*

### *Middle School Mathematics Teachers' Views on Students' Reactions to Mathematical Games*

The findings related to the eighth sub-problem of the study, “What are the views of middle school mathematics teachers on students' reactions to mathematical games?” are given in Table 9.

**Table 9.** Students' reactions to mathematical games

| **Theme** | ***f*** | **Participant** |
|---|---|---|
| Positive reactions | 13 | T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13 |
| Negative reactions | 6 | T1, T3, T5, T6, T9, T10 |

According to Table 9, students' reactions were grouped under two themes: *positive reactions and negative reactions.* According to Table 9, all 13 teachers who participated in the study stated that students reacted positively to the use of mathematical games. Reactions such as happiness, excitement, joy, interest, and willingness were coded under the theme of positive reactions. T10 stated that students reacted positively to the use of mathematical games because they liked games and explained this situation as follows:

> *Children generally react positively to the games. But there is also such a situation, sometimes if they like a game, when we try to play another game, they may say, “Teacher, let's play the other game, you know, we played it last lesson, it was very good”. So we may have a problem in choosing a game. But in general, when I say that we will play games in this lesson, I see that the children react positively. We don't get too many negative reactions, which is because they like to play games.*

According to Table 9, six teachers stated that students could react negatively as well as positively to the use of games. Here, reactions such as sadness, making noise, shyness and boredom were coded under the theme of negative reactions. Associating the negative reactions with the success of the students in the mathematics course, T1 expressed her views

as follows: “I think the students actually like it mostly. They are happy about it, but the student who does not understand, you know, the student with a low level of achievement, can be timid in the game because they already have difficulty in understanding the subject. We may encounter such a situation from time to time”.

### *Middle School Mathematics Teachers' Views on the Effects of Mathematical Games on Students*

The findings related to the ninth sub-problem of the study, “What are the views of middle school mathematics teachers on the effects of using mathematical games on students?” are given in Table 10.

**Table 10.** Effects of mathematical games on students

| Theme | | Code | *f* | Participant |
|---|---|---|---|---|
| Effects on learning situations | | Enables mental computation | 1 | T12 |
| | | Enables learning | 12 | T1, T2, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13 |
| | | Enables active participation | 2 | T5, T11 |
| | | Generates confusion | 2 | T1, T12 |
| Effects on attitudes toward the lesson | Positive attitude development | Provides motivation | 4 | T1, T5, T8, T10, T12 |
| | | Increases interest in the lesson | 4 | T1, T3, T5, T7 |
| | | Makes students love mathematics | 6 | T2, T3, T4, T5, T7, T9 |
| | | Breaks prejudice against mathematics | 3 | T2, T11, T13 |
| | Negative attitude development | Distracts from the lesson | 5 | T3, T6, T7, T10, T11 |
| Effects on personal development | | Provides empathy | 1 | T1 |
| | | Improves communication skills | 9 | T1, T3, T4, T5, T6, T7, T8, T9, T10 |
| | | Provides leadership qualities | 3 | T2, T4, T7 |
| | | Improves self-confidence | 6 | T5, T7, T8, T9, T11, T13 |
| | | Enables self-expression | 3 | T2, T6, T9 |
| | | Provides self-knowledge | 3 | T2, T3, T12 |
| | | Develops a sense of winning and losing | 1 | T3 |
| | | Develops a sense of solidarity | 2 | T3, T4 |
| Effects on social development | | Improves social skills | 2 | T1, T2, T8 |
| | | Allows to get to know each other | 1 | T2 |
| | | Enables collaboration | 3 | T2, T3, T4 |

The views of middle school mathematics teachers on the effects of mathematical games on students are presented in Table 10 under the themes *of effects on learning situations, effects on attitudes toward the lesson, effects on personal development and effects on social development.* According to Table 10, the effects of the use of mathematical games on students' learning situations were coded as: *Enables mental computation, enables learning, enables active participation, generates confusion.* According to Table 10, with the exception of one teacher, all other teachers stated that the use of mathematical games enabled learning. T11, who stated that mathematical games provided learning, expressed her thoughts as follows: "Learning becomes more permanent as the learning outcomes are put into practice". While T4 stated that mathematical games provide permanent learning, he also mentioned the positive effect of mathematical games on achievement. Here, permanent learning and success were coded as enabling learning. T4's views are given below:

> *It becomes easier to remember, easier to learn. I think that when the lesson they learned that day, when they make the acquisition playful, it is more permanent in the memories. Otherwise, we explained something and the child went home, it was a standard lesson, the possibility of forgetting it is much higher. But when there is a game, an experience, it increases permanence. I myself have witnessed that students compete with the other class over time, even if they were very low at the beginning, after three months, after five months, at the end of the year, and sometimes even get ahead.*

According to Table 10, the effects of mathematical games on students' attitudes toward the course were divided into two categories as *positive attitude development and negative attitude development*. Positive attitude development was coded as *provides motivation, increases interest in the lesson, makes students love mathematics, and breaks prejudice against mathematics*. On the other hand, negative attitude development was coded as *distracts from the lesson.* T3, who associated mathematical games to make students love mathematics and increase their interest in the lesson with the fun of the lesson, explained this situation as follows:

> *I think there must be students who don't like mathematics but they start to like it thanks to mathematical games. It is necessary to make the lesson more beautiful with this kind of fun activities instead of many ordinary, routine lessons, just telling the subject. Maybe this kinds of activities increased their interest in the lesson. They might have thought before, like "she is talking about it", but when we made them do this activity, they might think, "this lesson can be good, you can have fun in this lesson".*

According to Table 10, five teachers stated that mathematical games can develop negative attitudes and cause distraction from the lesson. T6, who thinks that the use of mathematical games has an effect on students such as developing negative attitudes, stated that students may be distracted from the lesson as follows: "*They believe that the lesson is distrupted, unfortunately they do not make any effort to learn the subject".*

According to Table 10, the effects of mathematical games on students' personal development were coded as *provides empathy, improves communication skills, provides leadership qualities, improves self-confidence, enables self-expression, provides self-knowledge, develops a sense of winning and losing, and develops a sense of solidarity*. For example, T6, who stated that mathematical games improve students' communication skills, explained this situation as follows:

> *I can bring together students who are less communicative, and if there are students who don't talk at all, at least they have an idea with group work. The student who is*

*silent, who is completely isolated from the class, becomes a little more involved in the class thanks to the game.*

According to Table 10, teachers stated that mathematical games affect social skills. The effects of mathematical games on social development were coded as *improves social skills, allows to get to know each other, and enables collaboration.* T1, who stated that mathematical games improve students' social skills, expressed her thoughts while associating social skills with group games as follows: "Games played with a group improve social skills more than games played individually".

### *Middle School Mathematics Teachers' Suggestions on Mathematical Games and the Use of Mathematical Games*

In the last part of the interviews, teachers were asked for their suggestions on mathematical games and the use of mathematical games. The findings related to teachers' suggestions are presented in Table 11.

**Table 11.** Middle school mathematics teachers' suggestions on mathematical games and the use of mathematical games

| Code | *f* | Participant |
|---|---|---|
| Material and resource support should be provided | 5 | T4, T5, T7, T12, T13 |
| Curriculum and lesson hours should be regulated | 4 | T3, T7, T9, T13 |
| Well-designed games should be used | 2 | T1, T8 |
| Games should be used at lower grade levels | 1 | T8 |
| Interactive games should be used | 1 | T10 |

According to Table 11, teachers' suggestions for mathematical games and the use of mathematical games were coded as: *material and resource support should be provided, curriculum and lesson hours should be regulated, well-designed games should be used, games should be used at lower grade levels, and interactive games should be used.* Suggesting the organization of the curriculum and lesson hours, T9 expressed her thoughts as follows: "If the curriculum and lesson hours is organized in a way that can include games, I think we can use games more effectively". Suggesting that well-designed games should be used, T8 expressed her thoughts as follows: "In my opinion, it is a well-planned game with well-defined rules, well-drawn framework, well-planned game; let's play, what are we going to play, what are the rules, what will happen if this happens, what will happen if that happens, we need to determine these well".

## Discussion

In the study, the views of middle school mathematics teachers on the concept of mathematical games were investigated. In the definitions made, entertaining, intriguing and endearing mathematics were emphasized in the affective dimension. In the content dimension, they defined mathematical games as being related to daily life, involving mathematical operations/mathematics, involving the history of mathematics, and involving drama. In line with the findings, it was seen that teachers focused on the positive features of mathematical games in their definitions of mathematical games. From the definitions made by the teachers, it can be said that they have positive thoughts toward mathematical games, and the study conducted by Özata (2019) also supports this finding.

In the study, teachers' views on the relationship between the concepts of mathematics and games were also examined. As a result of the current study, the idea that mathematics and

games are seen as a part of our daily lives draws attention. It is seen that mathematics is present in simple or complex ways in the games played by human beings at all ages (Uğurel & Moralı, 2008).

In the study, the use of mathematical games by middle school mathematics teachers was examined. It was observed that all of the teachers used mathematical games in their lessons. It is seen that the games used by the teachers are mostly paper and pencil games and digital games. In the study conducted by Baran Kaya and Gökçek (2021), it was stated that teachers mostly preferred card games. Within the scope of digital games, the use of smart boards and EBA (Education Information Network) draws attention. It is important that the games preferred by teachers are easily accessible and easily applicable (Çil & Sefer, 2021; Doğan & Sönmez, 2019). In the study, teachers reported that they did not use mathematical games very often. Teachers explained the reason for this situation as difficulties in completing the curriculum on time and in allocating time. One of the main difficulties in using games in the classroom is the allocation of time due to the curriculum (Çil & Sefer, 2021). It was found that teachers used mathematical games mostly at the end of the lesson/subject. Teachers explain this situation with the idea that games can be used after the subject is learned.

When the grade levels at which teachers used mathematical games were examined, it was seen that games were used at all grade levels. However, it was observed that teachers mostly preferred to use games at the fifth and sixth grade levels. In the studies on mathematical games, it can be seen that the primary school group is predominant and the groups that have more interaction with games in their daily lives are the primary and middle school groups (Gözel & Toptaş, 2023; Uluçay & Çakır, 2014).

When the views of the teachers on the purposes of using mathematical games were examined, it was seen that teachers mostly used mathematical games to ensure active participation and to make the lesson fun. In the literature, there are studies indicating that mathematical games make the lesson fun, students participate more actively, and the lesson is more interesting (Çil & Sefer, 2021; Hoşgör, 2010; Kiili et al., 2014; Özata, 2019; Uluçay & Çakır, 2014). Fouze and Amit (2018) associated the use of games in mathematics teaching with the fact that children like games, that is, the things they like attract their attention.

In the current research, it was found that teachers preferred mathematical games to be intriguing and entertaining. This result can be associated with the fact that one of the purposes of using mathematical games is to attract attention. Research shows that mathematical games enable students to learn by having fun (Ayvaz Can, 2020; Fouze & Amit, 2018).

As a result of the research, it was seen that teachers thought that mathematical games were beneficial for learning. In the study conducted by Ateş and Bozkurt (2021), it was stated that mathematical games facilitate learning and provide permanent learning. Studies also show that mathematical games support mathematical development and improve learning (Alanazi, 2020; Cohrssen & Niklas, 2019; Maryani, 2019; Moyer et al., 2019).

Regarding the difficulties in using mathematical games, it was found that teachers had more difficulties in allocating time and game management. It is known that teachers have responsibilities such as controlling the game, observing the students and the environment for the use of educational games in mathematics teaching (Wood, 2009). All these responsibilities can be associated with teachers' classroom management. In this context, while teachers take an active role in the use of games in lessons, it is known that teachers generally have difficulty in classroom management for game use (Çil & Sefer, 2021). In addition, it was found that teachers also stated that they had difficulties in the game design/planning process. Fiorella et al. (2019) also emphasized the importance of designing appropriate games for

mathematical game use. Similarly, Bullock et al. (2021) stated that the design should be of high quality, especially in digital games.

As a result of the research, all of the teachers stated that students reacted positively to mathematical games. However, some of the teachers stated that students may also react negatively to mathematical games. Adıgüzel (2018) stated that students may be tense depending on winning and losing situations in educational games. It can be thought that this situation may cause negative reactions. As a result of the current research, in the opinions of the teachers regarding the benefits of mathematical games, it was stated that mathematical games provide learning. Similarly, many studies indicate that mathematical games increase permanent learning and success (Başün & Doğan, 2020; Canbay, 2012; Denli, 2021; Fajri, 2020; Ku et al., 2014). Similarly, teachers mostly stated that mathematical games develop positive attitudes and provide motivation. Rawansyah et al. (2021) also reported that mathematical games increase motivation and interest in the lesson. It was found that the majority of the teachers felt that mathematical games increase students' communication skills and provide self-confidence. In the study conducted by Ku et al. (2014), it was concluded that games positively affect self-confidence. In addition, it was also found that there were opinions that mathematical games improve social skills. Efe Kendüzler (2023) stated that mathematical games increase student-teacher interaction. In the study conducted by Darragh (2021), it was stated that mathematical games increased cooperation among students.

In the current research, middle school mathematics teachers' views on the concept of mathematical games in various dimensions were examined and it was seen that teachers had a general knowledge about the concept of mathematical games. It was determined that teachers used mathematical games at least once and reflected a positive views on mathematical games. It was seen that the teachers supported the idea that mathematical games are useful and have positive effects. It was concluded from the teachers' opinions that students like mathematical games and this situation is effective in developing positive attitudes toward mathematics. In this direction, it can be suggested to use mathematical games in the mathematics learning and teaching process. However, it was found that teachers experienced various difficulties in using mathematical games. In this direction, it can be suggested to provide support to teachers in overcoming these difficulties. Similarly, it can be suggested to create resources for teachers and students to access mathematical games easily.

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