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Reflections of Mind Games Used in Primary School Mathematics Lessons on Teaching and Learning Process: A Case Study

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ABSTRACT

This study focused on the opinions of classroom teachers regarding the reflections of mind games used in mathematics lessons on the teaching and learning process. Case study design, which is one of the qualitative research types, was used in the study. The views of 15 classroom teachers, who used mind games in primary school mathematics lessons and received training on mind games were examined. The criterion sampling method was followed to identify the teachers, who would participate the study. The interview and observation forms developed by the researcher were used to collect the data. Content analysis method was used to analyse the data gathered. The content analysis findings presented the participant's opinions in 14 categories grouped around five themes. As a result of the research, it was determined that classroom teachers used brain teasers to improve students' mathematical skills and to increase their motivation and interest in the lesson. In addition, it was determined that classroom teachers frequently used mind games based on reasoning and operation games in mathematics lessons. In addition, it was concluded that mind games used in the process of teaching and learning mathematics contribute to both cognitive development and social and emotional development of students. Finally, it was determined that classroom teachers experienced difficulties arising from teaching, students and school in the mathematics teaching process supported by mind games. For this reason, a mind games activity guide can be prepared by classroom teachers in primary school mathematics lessons.

Keywords: Primary school mathematics lesson, mind games, case study.

Introduction

One of the main academic subjects that provide useful information for day-to-day living and is essential to personal growth is mathematics. However, mathematics is generally considered discouraging for primary and secondary school students (Sun et al., 2021). The same study also revealed that students prefer something other than mathematics because it is difficult to learn, boring, and useless. Additionally, it is also emphasized that students who have problems learning mathematics will be disadvantaged in their career development and professional life (Kiili et al., 2015). Thus, creating and implementing efficient strategies to boost students' enthusiasm for mathematics and advance their understanding of the subject is critical (Pope & Mangram, 2015). This situation will lead researchers, teachers, and policymakers to explore alternative teaching approaches, especially game-based learning.

Students are expected to possess advanced cognitive abilities in the twenty-first century, including creative thinking, critical thinking and problem-solving. In this context, higher-order thinking skills should be provided to students to educate them in line with the age requirements. In 2024, the Ministry of National Education reformed the curriculum that considers the K12 essential competencies and will be implemented throughout the country (MoNE, 2024). With the curriculum reform, it was emphasized that traditional teaching methods should be transformed and students' skills such as critical thinking, mathematical reasoning, cooperation, problem-solving, and communication skills should be developed. It is thought that mind games, which are evaluated within the scope of game-based learning, will support students' high-level thinking skills as they enable learning by doing and active learning practices (Terzi & Küçük-Demİr, 2022). Using game-based instruction, which forms the basis of primary school and is one of the effective teaching strategies for math instruction, in mathematics lessons is an problem that requires investigation. The purpose of this

study is to investigate the opinions of classroom instructors, who are vital to the teaching of mathematics in elementary schools, on the use of mind games in math classes.

Game-Based Learning

An increasing body of research in education shows that people are curious about the possible effects of using games in the classroom on student progress (Qian & Clark, 2016). Games used in elementary school mathematics lessons can make mathematical concepts concrete and associate abstract knowledge with concrete experiences. According to Piaget's theory of cognitive development, games can serve as concrete materials for primary school kids in the concrete operations period. Using games in the teaching and learning process of elementary school mathematics can increase students' participation in lessons and academic achievement (Hwang & Chen, 2022). In addition, games increase student motivation and improve problem-solving and critical thinking skills (Cicchino, 2015; Deng et al., 2020). A learning environment that incorporates knowledge and skills into games and helps students learn through problem-solving, competitiveness, and teamwork while playing games is known as "game-based learning. (Deng et al., 2020; Qian & Clark, 2016). Game-based learning has generally positive contributions to student achievement. However, some educators emphasize that students with insufficient knowledge and low self-efficacy may be anxious while playing games, negatively affecting student learning (Vandercruysse et al., 2013). Furthermore, it is stated that students who do not know about the functioning and use of games may have negative emotions (Yang et al., 2018).

Game-Based Mathematics Teaching

According to studies, children find games entertaining and exciting when studying mathematics through games (Deng et al., 2020). In addition, students stated that they can learn better by feeling challenged in game-based learning and that games provide permanent learning (O'Rourke et al., 2013). Furthermore, it is emphasized that game-based mathematics teaching has a positive effect on students' self-efficacy (Ninaus et al., 2017). In some studies, it is stated that there is a high level of participation in game-based mathematics teaching at the beginning, but when it lasts longer than one semester, participation decreases (Deater-Deckard et al., 2014; Deng et al., 2020). Research also reveals that teachers tend to prefer traditional teaching methods over game-based mathematics instruction (Yong et al., 2016).

While a large body of research has looked at the effects of game-based learning in mathematics classes, less has been done to explore the perspectives, experiences, and difficulties teachers and students have had when using game-based learning (Deng et al., 2020). The acceptance of game-based learning by educators and learners, who are seen as the primary change agents in the classroom, will determine the effectiveness of its implementation. Thus, a key determinant of the viability of this approach is the opinions and experiences that educators and learners have with play-based learning. In this context, it is necessary to determine the experiences, perceptions, and difficulties faced by teachers and students for game-based mathematics teaching in which students actively participate instead of using traditional teacher-centered teaching in primary school mathematics lessons.

It can be stated that educational games play an important role in the process of teaching and learning mathematics. These games can provide a fun and interactive environment for students to acquire knowledge and skills. In this regard, various forms of educational games can be used during teaching and learning. One of the educational game types is mind games. Mind games are specifically designed to develop cognitive skills and can also support higher-order thinking skills such as reasoning, problem-solving, and analytical thinking. By using mind games, educators and parents can make students' learning processes fun and interactive.

Mind Games in Mathematics Teaching

Mind games are defined as games that increase individuals' awareness of their competencies, enable them to produce alternative solutions to their problems, and support their decision-making processes (Durmaz & Can, 2020). Mind games are used in mathematics teaching, thanks to their advantages. As a matter of fact, studies indicate that there is a strong relationship between students' academic achievement and their ability to play mind games (Şahin & Tezci, 2023). This study found that as the time students spent on word puzzles and mind games increased, their math achievement also increased. It was also stated that mind games encourage mathematical thinking and contribute to meaningful learning (Ergül & Erşen, 2023). On the other hand, mind games enable individuals to use and improve their cognitive skills, such as reasoning, problem-solving, memory, attention, and strategy development (Durmaz & Can, 2020).

The use of mind games in mathematics teaching has been found to support students' problem-solving, mathematical reasoning, and spatial thinking skills (Demirel & Karakuş-Yılmaz, 2019; Şahin & Tezci, 2023; Şanlıdağ & Aykaç, 2021). It was also found to support students' higher order thinking

skills (e.g., critical and creative thinking) (Terzi & Küçük Demİr, 2022). Finally, it is stated that mind games increase motivation for mathematics lessons and contribute to the advancement of mathematical skills in the process of teaching and learning mathematics (Cicchino, 2015).

When the studies on the use of mind games in mathematics lessons were examined, it was seen that the studies generally focused on the secondary school level (Demirel & Karakuş-Yılmaz, 2019; Şanlıdağ & Aykaç, 2021; Terzi & Küçük-Demir, 2022). In these studies, the effects of mind games on middle school students' problem solving (Demirel & Karakuş-Yılmaz, 2019), reflective thinking (Şanlıdağ & Aykaç, 2021) and creative thinking (Terzi & Küçük-Demir, 2022) skills were examined. On the other hand, a limited number of studies were found on the use of mind games in primary school mathematics lessons (Şahin & Tezci, 2023). In this study, the effect of mind games on the problem solving skills of primary school students was examined. When the studies conducted are examined, it can be stated that there is a need for studies that examine the reflections of mind games used in primary school mathematics lessons on the teaching and learning process of mathematics and describe the process in detail.

In this study, according to the opinions of classroom teachers, the reasons for the use of mind games used in primary school mathematics lessons, types, subjects used, their reflections on the mathematics teaching and learning process and the difficulties encountered in the process are discussed. With the related questions, the reflections of mind games on primary school mathematics lessons will be described in depth according to the opinions of classroom teachers. This study is expected to be a guide for classroom teachers, researchers and policy makers working in the field. As a matter of fact, teachers' perceptions and experiences about the reflections of mind games on the mathematics teaching and learning process can be used to decide whether mind games can be successfully implemented in primary school mathematics lessons. In addition, determining the types of mind games used by classroom teachers in primary school mathematics lessons and the related subjects may contribute to the effective use of mind games in mathematics lessons.

Purpose of the Study

This study aims to examine the views of classroom teachers on the reflections of mind games used in mathematics lessons on the teaching and learning process. In this context, the following research questions guided the study.

- What are the reasons for classroom teachers' use of mind games in primary school mathematics lessons?
- What are the types of mind games used by classroom teachers in primary school mathematics lessons?
- What are the reflections of mind games used in primary school mathematics lessons on mathematics teaching and learning process?
- Which mathematics topics are associated with the mind games used by classroom teachers in primary school mathematics lessons?
- What are the challenges faced by classroom teachers in the process of teaching and learning mathematics supported by mind games?

Methods

Research Design

This study aims to examine the opinions of classroom teachers about the mind games used in primary school mathematics lessons. For this purpose, the study was conducted with a case study, which is one of the qualitative research designs (Creswell, 2012). In case studies, one or several situations are investigated with a holistic approach and the focus is on how they affect the relevant situation and how they are affected by the relevant situation (Yıldırım & Şimşek, 2016). This study was designed as a case study in order to reveal classroom teachers' experiences, practices, preferences and the effects of the process regarding the mind games they use in primary school mathematics lessons in a holistic way.

Study Group

In case study research, data sources are picked from persons or groups who experience the phenomenon that the study focuses on and can explain or reflect it (Yıldırım & Şimşek, 2016). In this study, the experiences of classroom teachers who use mind games in elementary school mathematics lessons were discussed. Researchers state that the study group in such studies should be between 10-15 people (Creswell, 2012; Yıldırım & Şimşek, 2016). Since the interviews with the participants will take a long time and even consist of several sessions and in-depth data will be collected, it is natural to keep the study group limited. The teachers who will participate in the investigation were chosen using the criterion sampling method. As criteria, the conditions of receiving training on mind games and using mind games in mathematics lessons were taken into consideration. Official permissions were obtained from the Provincial Directorate of National Education to determine the study group. Secondly, preliminary interviews were conducted with classroom teachers to determine whether they met the necessary criteria. The study group consisted of 15 classroom teachers, eight female and seven male, who met the relevant criteria and volunteered. The study group was limited to this number since data saturation was

achieved. While presenting the findings, the code names of the participants were preferred and the initials of the names were used. Demographic information of the participants is presented in Table 1.

Table 1.

Demographic data of the study group

Teacher	Professional experience	Gender	Teaching class	Education level	Mind game experience *
Aliye	14	Female	3rd grade	Undergraduate	IT, SC
Berna	23	Female	3rd grade	Undergraduate	SC
Ceren	9	Female	3rd grade	Undergraduate	MGC
Derya	21	Female	4th grade	Master's degree	MGC, IT
Emrah	16	Male	1st grade	Master's degree	IT
Fatih	5	Male	2nd grade	Undergraduate	SC
Gamze	8	Female	2nd grade	Master's degree	IT, MGC
Halil	6	Male	4th grade	Undergraduate	SC
İlkin	15	Female	3rd grade	Master's degree	IT
Kemal	17	Male	3rd grade	Doctorate	MGC, IT
Leyla	14	Female	4th grade	Undergraduate	SC
Mert	13	Male	4th grade	Master's degree	IT
Nalan	20	Female	2nd grade	Undergraduate	SC
Osman	8	Male	1st grade	Doctorate	IT, SC, MGC
Ömer	7	Male	4th grade	Undergraduate	MGC, IT

** IT: In-Service Training; SC: Selective Course; MGC: Mind Games Course*

Data Collection Tool

Data for this study were acquired through interviews with classroom teachers and lesson observations conducted by the researcher. The interviews were conducted using a semi-structured interview form prepared by the researcher. Semi-structured interviews are an interview technique in which both pre-prepared questions are asked and additional questions are asked to get detailed information about these questions (Patton, 2021). The relevant form was developed by the researcher after reviewing the literature. The draft form consists of seven questions and probes under each question. The draft form was presented to two experts who have studied primary school mathematics education and mathematics teaching with mind games, and their opinions were obtained. In this sense, the experts were asked to evaluate the questions in terms of meaning, form, and appropriateness to the subject and teachers. As a result of the expert evaluations, one question was removed as it did not serve the purpose. In addition, two questions serving the same purpose were combined. Then, the suitability of the interview form in terms of language and expression was evaluated by taking the opinion of an expert in the field of Turkish education. After receiving expert opinion, it was determined that the form was appropriate in terms of language and expression. Before finalizing the form, it was applied to two classroom teachers to check the comprehensibility of the questions. Both teachers stated that the questions were understandable. In the semi-structured interview form, questions such as "how does the use of mind games in mathematics lessons reflect on the mathematics teaching process?" "Which mathematics subjects are associated with mind games?" and "What are the difficulties encountered in using mind games in mathematics lessons?" were included.

In order to confirm the data collected from the interviews, the researcher made observations in mathematics lessons where mind games were used. Observations were made using the observation form prepared by the researcher. The observation form included the questions in the interview form. In this context, the researcher observed the math lessons of two volunteer classroom teachers. A total of eight lessons were observed, four lessons for each teacher.

The ethical process in the study was as follows:

- Ethics committee approval was obtained from Bayburt University Ethics Committee (Date: 04.07.2024, Number: E-79126184-299-206392)
- Informed consent has been obtained from the participants.

Data Analysis

Content analysis method was used to analyze the data obtained. In this way, concepts and relationships that will explain the data obtained are reached (Yıldırım & Şimşek, 2016). In content analysis, similar data are brought together within the plan of sure themes and explained by organizing them in a way that the reader can understand (Patton, 2021; Yıldırım & Şimşek, 2016). The content analysis method was preferred in this study because the themes that explain the data obtained by organizing the emerging concepts and relationships in a logical way will be determined. Within the scope of content analysis, the interviews recorded with a voice recorder were first transcribed. Then, the researcher coded the transcribed data. After coding, themes and categories were determined by considering common patterns and structures. The coding and themes were coded by a different researcher who was not in the study, and the agreement rate between the two researchers was calculated.

Validity and Reliability

In qualitative research, certain measures are taken to ensure validity and reliability (Yıldırım & Şimşek, 2016). Accordingly, in order to provide the internal validity in this research, expert views were consulted about the subject of the research and the suggestions of the experts were taken into consideration. Also, data triangulation was provided by utilizing a variety of data collection instruments during the data collection period. To provide external validity, direct quotations expressing the participants' opinions were frequently used in the presentation of results. Again, in order to ensure external validity, the participant group was selected using a criterion sampling method is used in accordance with the aim of the study. In order to ensure internal reliability in this study, the data obtained from the interviews were coded by two expert researchers, and the coding of the two expert researchers was compared. The Miles and Huberman (1994) formula was used to calculate inter-coder reliability, which was 0.94. The agreement rate amongst coders should be at least 0.80 (Miles & Huberman, 1994). In order to ensure external reliability, the researcher kept the raw data to confirm the results.

Results

In this study, the findings were shaped by considering the research questions. In this context, the findings were presented under five themes. These themes are listed as the reasons for using mind games in mathematics lessons, types of mind games used in mathematics lessons, reflections of mind games on mathematics teaching and learning process, mathematics subjects in which mind games are used, difficulties encountered in the mathematics teaching process supported by mind games. The themes and categories are presented in Figure 1.

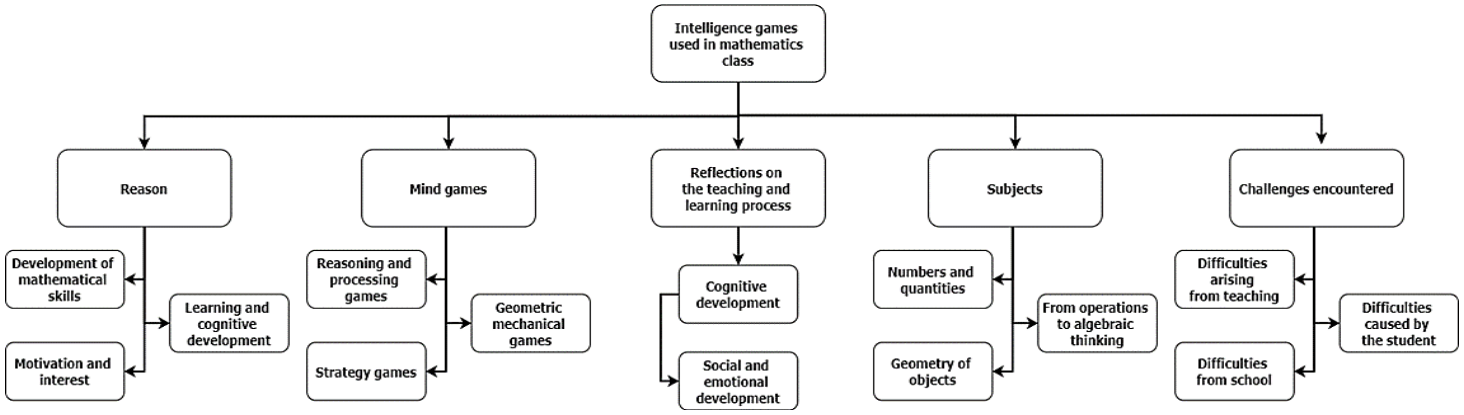

Figure 1.

Distribution of themes and categories included in the research

Reasons for Using Mind Games in Mathematics Lessons

First, the findings regarding the reasons for using mind games in mathematics lessons were discussed. The findings are presented in Table 2 in three categories: development of mathematical skills, learning and cognitive development, and motivation and interest.

Table 2.

Distribution of the Reasons for Using Mind Games in Mathematics Lessons According to Participants

Category	Code	A	B	C	D	E	F	G	H	İ	K	L	M	N	O	Ö	f
Development of mathematical skills	Improving problem solving skills	*		*		*	*				*			*			6
	Improving mathematical calculation skills		*				*		*								3
	Supporting strategy development capabilities						*							*			2
	Discovering alternative solutions							*						*			2
	Improving mathematical thinking skills										*					*	2
	Supporting visual and spatial skills										*						1
Learning and cognitive development	Supporting higher order thinking (reasoning, critical thinking, etc.) skills	*			*	*	*				*		*	*	*		8
	To ensure permanent learning		*							*					*		3
	Teaching geometric shapes		*														1
	Concrete concepts			*													1
	Individualizing learning				*												1
Motivation and interest	Making math class fun		*	*	*	*			*	*	*	*				*	9
	To increase their motivation for mathematics lessons			*	*				*	*			*		*	*	7
	Take attention			*		*			*	*			*				5
	Reinforcing mathematical knowledge							*					*				2

An analysis of Table 2 reveals that the following results are obtained reasons for classroom teachers' use of mind games in mathematics lessons are classified into three categories. In this context, it was observed that classroom teachers used mind games in mathematics lessons to improve mathematical skills, ensure learning and cognitive development, and increase motivation and interest. In the category of developing mathematical skills, it was seen that the most commonly expressed reasons by classroom teachers were to improve students' problem-solving skills (f=6) and mathematical operation skills (f=3). Mind games can support students' problem-solving skills as they provide the opportunity to apply logical thinking and problem-solving strategies. In the category of learning and cognitive development regarding the reasons for using mind games in mathematics lessons, it was seen that the most commonly expressed reasons by classroom teachers were to support students' high-level thinking skills (f=8) and to provide permanent learning (f=3). In the category of motivation and interest in the reasons for using mind games in mathematics lessons, classroom teachers expressed the codes of making mathematics lessons fun (f=9), increasing students' motivation for mathematics lessons (f=7), and attracting attention (f=5) as reasons for using mind games in mathematics lessons. The observation report that supports these findings is as follows: "The teacher used the Qbitz mind game to attract student's attention and increase their motivation while explaining geometric patterns. It was observed that students were interested in the brain teaser (GT: 27.05.2024; İlkin)". Sample teacher opinions on the reasons for using mind games in mathematics lessons are presented below.

Kemal: I use them to develop children's problem-solving and reasoning skills, to make them think fast, to develop visual and mathematical mind, and to make learning fun.

Nalan: As someone who knows that mind games contribute to students in terms of reasoning, problem-solving, and analytical thinking, I definitely include them in mathematics lessons...

Ilkin: I use mind games to make mathematics more fun and enjoyable, to attract students' attention, to make them love mathematics, and to improve students' math skills.

Osman: In math lessons supported by mind games, students learn by having fun, and this increases their motivation for math lessons.

Types of Mind Games Used in Mathematics Class

Secondly, findings regarding the types of mind games used by classroom teachers in primary school mathematics classes are presented. The findings are presented in Table 3 in three categories: reasoning and operation games, geometric mechanics games, and strategy games.

Table 3.

Distribution of the types of mind games used in primary school mathematics classes according to participants

Category	Code	A	B	C	D	E	F	G	H	İ	K	L	M	N	O	Ö	f
Reasoning and processing games	Sudoku	*			*	*	*	*			*	*		*	*	*	10
	Apartments	*					*				*				*		4
	Kakuro			*			*										2
	Process square			*			*			*							3
	Trading games				*						*					*	3
	Kendoku			*	*		*										3
	Bump						*					*					2
	Logic puzzles			*		*											2
	Other (Kenken, mind cards, ABC binding)			*	*									*			3
Geometric-mechanical games	Tangram	*	*		*						*			*	*	*	7
	Qbitz		*					*									2
	Color blocks							*				*					2
	Equilibrio									*							1
	Math puzzles				*												1
Strategy games	Mangala		*			*			*				*				4
	Checkers				*						*						2
	Chess												*				1

When Table 3 is analyzed, it can be stated that classroom teachers used different types of mind games in mathematics lessons. The mind games used by the teachers were categorized under three headings. It was observed that classroom teachers frequently used reasoning and operation games (f=32). It can be stated that reasoning and operation games are frequently applied by different teachers. Based on this situation, it can be said that teachers tend to prefer widely known (for example, sudoku, tangram, Mangala, etc.) mind games. In the category of argument and operation games, it was checked that teachers generally used sudoku (f=10) in mathematics lessons. In addition, it can be stated that they also prefer mind games such as apartments (f=4), kakuro (f=2), and operation squares (f=2). In the category of geometric-mechanical games, it was observed that classroom teachers generally used tangram (f=7) in mathematics lessons. It can also be stated that they preferred mind games such as Qbitz (f=2) and colored blocks (f=2). In the category of strategy games, it was observed that classroom teachers generally used mind games such as Mangala (f=4) and checkers (f=2) in mathematics lessons. In different lesson observations, it was observed that classroom teachers played kokuro, kendoku, tangram, and mangala. Sample teacher views on the types of mind games used in mathematics lessons are given below.

Fatih: Mind games are played with certain steps and strategies. With this logic, students learn to use strategies and step-by-step operations in mathematics lessons. I use sudoku and its derivatives, kakuro, kenken, and Apartman mind games, in mathematics lessons.

Leyla: Finding solutions and recognizing clues are the most important factors that contribute to math lessons. Sudoku, linking letters, and tangrams provide this.

Aliye: I use tangram because it supports math subjects.

Gamze: I use Qbitz and Sudoku because they require thinking about different possibilities. The connection with mathematics allows you to reach the solution quickly and, at the same time, develop different solutions.

Halil: I use mangala because I think it contributes to faster processing...

Mind Games: Reflections on the Math Teaching and Learning Experience

Thirdly, the reflections of the mind games used by classroom teachers in mathematics lessons on the mathematics teaching and learning experience were discussed. The reflections of mind games on the mathematics teaching and learning experience are categorized under two headings: Cognitive development and social and emotional development. The results acquired in this context are presented in Table 4.

Table 4.

Participants' views on the reflections of mind games on mathematics teaching and learning

Category	Code	A	B	C	D	E	F	G	H	İ	K	L	M	N	O	Ö	f
Cognitive development	Contributes to meaningful and permanent learning	*	*	*	*		*	*	*	*	*				*	*	11
	It enables them to produce alternative solutions to problems		*					*	*	*	*	*	*	*	*	*	11
	Supports higher-level thinking skills	*	*		*	*	*		*		*		*	*			9
	Improves students' problem-solving skills		*	*	*	*			*	*	*		*	*			9
	Allows abstract concepts to be concretized			*	*	*						*		*			5
	Allows students to experience a sense of success		*	*	*								*				4
	Supports students' decision-making skills		*					*		*			*				4
	Makes it easier to learn mathematical concepts and relate them to daily life	*		*	*								*				4
	Provides benefits in measurement and evaluation			*					*				*				3
Social and emotional development	It positively affects the attitude towards mathematics class.		*	*	*	*	*		*	*	*		*	*	*	*	12
	Increases motivation for math class	*	*	*	*	*	*		*	*			*		*		10
	Contributes to students' social skills (self-confidence, etc.)		*	*	*		*	*	*	*			*			*	9
	Makes lessons fun		*	*	*		*				*						5
	Supports communication skills		*					*				*	*				4
	Supports collaboration and teamwork				*	*	*										3

According to the views of classroom teachers, the reflections of mind games on the mathematics teaching and learning process are generally positive. In the cognitive development category, according to the opinions of classroom teachers, it was determined that the mind games used in the mathematics teaching and learning process contribute to meaningful and permanent learning (f=11) and enable students to produce alternative solutions to problems (f=11). In addition, it was stated by the classroom teachers that the mind games used in mathematics lessons support students' higher-order thinking (f=9) and problem-solving skills (f=9). The observation report expressed by the researcher during the observation supports the related findings: "The tangram mind game used by the classroom teacher while teaching the subject of length measurement contributed to the students' development of alternative solutions to problems. In addition, the teacher used the tangram mind game to evaluate student learning (GT: 30.05.2024; Fatih)". Sample teacher opinions regarding the codes in the cognitive development category are expressed below.

Kemal: Mind games improve problem-solving skills over time by contributing to multidimensional thinking of problems and finding different and practical solutions.

Ceren: It is effective in developing different solution ways, seeing the solution to the problem quickly, and reaching the solution in a short and quick way.

Derya: Since concepts or names are based on rote memorization, they can be forgotten quickly when a meaningful relationship or connection is not established between them, but giving these concepts through activities or games can shorten the learning time and provide permanent learning.

In the social and emotional development category, according to the opinions of classroom teachers, it was emphasized that the mind games used in the mathematics teaching and learning experience positively affected students' attitudes towards mathematics (f=12) and increased student motivation for mathematics (f=10). Possible reasons for this may be that students experience a sense of achievement during the game and learn by playing. Furthermore, classroom teachers also stated that mind games used in mathematics lessons support students' social skills (f=9). Playing mind games in groups can support students' social skills. During the lesson observations, it was observed that the mind games used in mathematics lessons made the lessons fun: "It was observed that the colored blocks used by the teacher while teaching geometric shapes made the lesson fun for the students. In fact, it was determined that students learned by having fun and exhibited more enthusiastic behaviors (GT: 28.05.2024; İlkin)". Sample teacher opinions regarding the codes in the social and emotional development category are given below.

Emrah: ...It can be stated to have a good effect on students' attitudes toward mathematical lessons. At least the lesson becomes a fun lesson instead of a fearful

dream.

İlkin: Students are more enthusiastic in games, and a student who is timid when solving a normal math problem can act more willingly and confidently.

Gamze: Being successful increases an individual's self-confidence. To succeed also means to be able to do, and what is done is liked and liked to be done. This means that we can make students love mathematics and increase their success in mathematics through games and fun.

Mathematics Topics Using Mind Games

Fourthly, mathematics topics in which mind games were used were discussed. The mathematics topics in which classroom teachers used mind games were presented in three categories: numbers and quantities, operations to algebraic thinking, and geometry of objects. The results achieved in this context are presented in Table 5.

Table 5.

Distribution of mathematics subjects in which mind games are used according to the participants

Category	Code	A	B	C	D	E	F	G	H	İ	K	L	M	N	O	Ö	f
Numbers and quantities	Numbers	*		*	*		*				*					*	6
	Patterns		*	*	*			*						*			5
	Rhythmic counting											*	*				2
	Fractions						*	*									2
	Odd and even numbers								*			*					2
From operations to algebraic thinking	Problem solving			*	*	*		*			*	*	*	*	*	*	10
	Arithmetic operations	*	*	*	*				*	*	*		*	*	*		10
	Algebra teaching						*	*									2
Geometry of objects	Geometrical shapes	*	*	*	*			*			*						6
	Geometry				*	*			*			*		*	*		6
	Spatial relationships		*	*													2
	Geometric concepts								*				*				2
	Symmetry								*			*					2

When Table 5 is examined, it can be stated that mind games are frequently used by classroom teachers in different subjects of mathematics. According to the opinions of classroom teachers, in the category of numbers and quantities, mind games were generally used in teaching numbers (f=6) and patterns (f=5), in the category of operations to algebraic thinking, in problem solving (f=10) and arithmetic operations, and in the category of geometry of objects, in teaching geometric shapes (f=6). Sample teacher opinions on this subject are presented below.

Leyla: Mind games are associated with all subjects of the mathematics course, gamification of all kinds of problems provides easy learning.

Ömer: Associations are more especially in problem solving subjects.

Challenges Encountered in The Experience of Teaching Mathematics Supported with Mind Games

Fifthly, the difficulties encountered by classroom teachers in the mathematics teaching process supported by mind games were discussed. The difficulties encountered in the mathematics teaching experience were showed in three categories as disabilities arising from teaching, students and school. The results acquired in this context are presented in Table 6.

Table 6.

Distribution of the difficulties encountered in the mathematics teaching process supported with mind games according to the participants

Category	Code	A	B	C	D	E	F	G	H	İ	K	L	M	N	O	Ö	f
Difficulties arising from teaching	Time-consuming to implement			*	*	*	*			*	*	*	*			*	9
	Difficulty in planning the brain teasers used in mathematics lessons	*		*				*									3
	Difficult class domination				*				*		*						3
	Difficulties in evaluation			*	*												2
Difficulties caused by the student	Individual variances mean that mind games do not have the same effect on every pupil		*	*	*						*		*		*	*	7
	Inadequate prior knowledge of students about mind games	*					*				*						3
	Loss of interest due to overuse					*		*									2
Difficulties from school	Inadequate infrastructure (physical and technological)			*	*				*						*		4
	Lack of sufficient number of mind games		*						*					*			3
	The costliness of mind games		*						*					*			3
	Crowded class sizes					*								*			2

When Table 6 is examined, it can be stated that classroom teachers who use brain teasers in mathematics lessons face different disabilities in the mathematics teaching experience. In the category of difficulties arising from teaching, classroom teachers stated that mind games applied in mathematics teaching are time-consuming (f=9). In the category of student-related difficulties, classroom teachers emphasized that mind games applied in the mathematics teaching process do not affect each student in the same way due to individual differences (f=7). In the category of school-related difficulties, classroom teachers stated that schools are inadequate in terms of infrastructure (f=4) and that there are not enough mind games in schools (f=3). In the observations made, it was observed that classroom teachers had difficulty ensuring classroom dominance in mathematics lessons in which brain teasers were used. Sample teacher opinions about the difficulties encountered by classroom teachers in the use of brain teasers in mathematics lessons are presented below.

Emrah: If the class size is crowded, there may be time problems. If it is used too often, students may constantly ask for games and deviate from their purpose. Or it may not attract students' attention because it is used too much.

Berna: When there are not enough brain teasers for each student, it is difficult to reach all students. Since students have different types of mind, the brain teasers we use may not be suitable for every student.

Aliye: Every child in the class needs to have a good grasp of brain teasers and math. It requires special planning.

Conclusion and Discussion

This study, the views of classroom teachers and lesson observations made by the researcher regarding the use of brain teasers in elemantary school mathematics lessons were examined. The findings obtained from the classroom teachers' opinions and lesson observations were discussed in the context of the research questions. In addition, the results obtained in this study supported the literature to a great extent but also revealed original results that would contribute to the literature.

When the findings regarding the reasons for using brain teasers in mathematics lessons were examined, it was found that classroom teachers used brain teasers in mathematics lessons to improve students' problem-solving skills, to support higher-level thinking skills, to make the lesson fun and to increase students' interest in the lesson. This situation indicates that classroom teachers want to benefit from the advantages of brain teasers in primary school mathematics lessons. It can be said that the findings on the reasons for using brain teasers in mathematics lessons support the literature. As a matter of fact, similar findings were expressed in studies on the use of mind games in mathematics lessons (Durmaz & Can, 2020). On the other hand, in studies examining the advantages of mind games, it was appeared that mind games are impactful in developing students' problem-solving and reasoning skills (Şahin & Tezci, 2023; Şanlıdağ & Aykaç, 2021). In addition, thanks to mind games, students can gain high-level thinking skills by developing logic, thought, and

interpretation power (Kula, 2020). Students who play mind games develop skills such as strategic thinking, planning, generating alternative solutions, reasoning, and gaining different perspectives (Çalışkan & Mandacı-Şahin, 2019). In another study examining the impactful of the mind games lesson on student achievement, it was resulted that the problem-solving and reasoning skills of students taking this course improved (Şahin & Tezci, 2023). Finally, studies examining the use of mind games in mathematics lessons concluded that mind games make mathematics lessons fun and increase students' interest in the course (Deng, 2020). Since students learn by having fun, it can be interpreted as an expected situation in which their interest in the lesson increases.

When the findings regarding the types of brain teasers used in mathematics lessons were examined, it was found that classroom teachers generally preferred brain teasers based on reasoning and operation games in mathematics lessons. In addition, it was determined that classroom teachers used commonly known mind games such as sudoku, tangram, and Mangala in mathematics lessons. The fact that these games are easier to associate with mathematics subjects than other mind games can be shown as a reason for this situation. It is a known fact that mind games are effective in teaching mathematics subjects. For example, it was found that students who played the kendoku mind game, which is expressed in reasoning and operation games, were more successful in arithmetic operations, and their algebraic thinking skills improved (Reiter et al., 2014). In a study examining the reflections of mind games on second-grade primary school students, it was found that students had difficulty learning the rules of games such as sudoku and Mangala and playing these games (Kula, 2020). This may be justified by the fact that students have difficulty in learning and playing games that require high-level thinking skills based on reasoning because they are still in the second grade. In this study, it was determined that mind games such as chess and checkers, which are among the strategy games, were rarely used by classroom teachers in the mathematics teaching process. However, in studies examining the types of mind games used in mathematics lessons, it is stated that mind games such as chess, checkers, nine-tone, and Mangala support students' mathematical processes (Erdoğan et al., 2017). On the other hand, it is stated that mind games containing mathematics-oriented strategies have an important potential in teaching mathematical concepts (Erdoğan et al., 2017). However, it was emphasized that this potential can emerge with a well-planned instructional design (Deng et al., 2020). In order for brain teasers to make sense, the teacher's activity design skills and guidance are needed (Erdoğan et al., 2017). In addition, it was stated that mind games with a predominance of intuitive strategy could benefit students who have a prejudice against mathematics and have anxiety about learning mathematics (Erdoğan et al., 2017). It can be stated that the findings obtained about the types of mind games used in mathematics lessons support the literature. In addition, it can be stated that the findings on strategy games contradict the literature. In this context, possible reasons for the contradiction were discussed.

When the findings regarding the reflections of mind games on the mathematics teaching and learning process were examined, it was determined that the mind games used by classroom teachers in mathematics lessons contributed to cognitively meaningful and permanent learning, supported students' higher-level thinking skills, and improved their problem-solving skills. The results of this research are generally similar to the results of studies in the literature. Studies examining the reflections of mind games on the mathematics teaching process have determined that the mathematics teaching process integrated with mind games has a positive effect on students (Can, 2020; Kula, 2020). It is stated that mind games used in mathematics lessons facilitate student learning cognitively and contribute to permanent learning (Ergül & Erşen, 2023). Mathematics teaching supported by mind games appeals to different sensory organs and contributes to students' concretization of abstract concepts and meaningful learning. For example, the study conducted by Ergül and Erşen (2023) revealed that classroom teachers use games to ensure meaningful learning in mathematics lessons. Studies indicate that mathematics teaching enriched with mind games supports students' higher-level thinking skills, such as problem-solving, reasoning, evaluation, analysis, and association (Çalışkan & Mandacı-Şahin, 2019; Kula, 2020). It can be stated that the findings obtained in the cognitive development category support the literature regarding the reflections of mind games on the mathematics teaching and learning process.

In this research, it was determined that the mind games used by classroom teachers in the mathematics lesson positively affected the attitude towards the mathematics lesson in a social and emotional sense, increased the motivation for the mathematics lesson, and contributed to the social skills of the students. In studies examining the effects of using mind games in mathematics lessons on the social-emotional development of students, it has been determined that mind games make lessons fun and increase interest in the lesson (Can, 2020; Ergül & Erşen, 2023; Kula, 2020). Studies have stated that mind games used in mathematics lessons positively affect students' attitudes toward mathematics (Deng et al., 2020). In

addition, it has been determined that mathematics teaching supported by mind games contributes to learning by having fun, and the communication skills of students are supported thanks to the cooperation established (Ergül & Erşen, 2023). It can be stated that mathematics teaching supported by mind games has positive contributions to students both cognitively, socially, and emotionally. However, it is stated that students who have insufficient knowledge about mind games and low self-efficacy are anxious while playing games, and this negatively affects student learning (Vandercruysse et al., 2013). It is also emphasized that students who are not knowledgeable about mind games may have negative feelings toward the games (Yang et al., 2018).

When the findings regarding the mathematics subjects in which mind games were used were examined, it was determined that the mind games used in mathematics lessons were widely used by classroom teachers in subjects such as problem-solving, arithmetic operations, geometric shapes, and number teaching. In the study examining the opinions of classroom teachers on the use of mind games in primary school, teachers stated that they mostly benefited from mind games in teaching geometric objects in mathematics lessons (Güneş & Yünkül, 2021). Additionally, in the same study, it was determined that mind games were used in teaching subjects such as arithmetic operations, symmetry, problem-solving, and place and place value. Studies have shown that mind games are effective in teaching mathematics subjects. For example, in a study, it was determined that the kendoku mind game was used to teach algebra and arithmetic operations to students and that students were able to learn these subjects thanks to the mind game (Reiter et al., 2014). Although mind games are used by teachers in mathematics lessons, it can be stated that the studies examining the effect of mind games in teaching mathematics subjects are limited.

When the findings regarding the difficulties encountered in the mathematics teaching process supported by mind games were examined, the classroom teachers emphasized that it was difficult to plan the mathematics teaching process supported by mind games and that mind games were time-consuming in practice. It was also emphasized that the mind games used by classroom teachers in the mathematics teaching process do not affect every student in the same way due to individual differences and that schools are inadequate in terms of infrastructure for the implementation of mind games. When the studies on the use of mind games in the mathematics teaching process are examined, it can be stated that teachers are concerned about similar problems. In the mathematics teaching process supported by mind games, there are time problems due to preparation (Can, 2020), lesson time is not enough for such activities (Can, 2020), mind games do not have a similar effect for all age groups, and there are difficulties in classroom management (Ergül & Erşen, 2023) and requiring a certain cost (Can, 2020) were emphasized. It can be stated that the basis of the problems arising from the use of mind games in the mathematics teaching process is the teachers' knowledge and experience of mind games. As a matter of fact, it is known that teachers who are trained and have experience in using mind games in the mathematics teaching process encounter fewer difficulties in the process (Can, 2020; Kula, 2020).

Limitations and Directions for Future Research

The results of the research showed that the mind games used in mathematics lessons contributed to both the cognitive, social, and emotional development of primary school students. For this reason, it may be recommended that mind games associated with mathematics subjects be identified, which can be used by classroom teachers in primary school mathematics lessons and to support mathematics learning environments with mind games. In this regard, a mind games activity guide can be prepared for classroom teachers by researchers and the Ministry of Education.

In the research, it was determined that classroom teachers experienced various difficulties due to the application of mind games in primary school mathematics lessons. This may indicate that classroom teachers lack knowledge and experience in mind games. In this context, theoretical and applied elective courses on the use of mind games in mathematics lessons can be opened in education faculties for prospective classroom teachers. At the same time, practical and long-term in-service training can be given to classroom teachers on enriching mathematics lessons with mind games.

In this research, it was determined that mind games such as chess and checkers, which are among the strategy games, were rarely used by classroom teachers in the mathematics teaching process. Considering that strategy games such as chess and checkers support students' mathematical processes, in-service training can be given to classroom teachers on these games.

This research has some limitations. The first of these limitations is related to the method. Since this research was designed using the case study method, only qualitative data was analyzed. Future research on the use of mind games in teaching mathematics can contribute to this issue by

supporting it with quantitative data and explaining it with experimental processes. In this context, long-term longitudinal studies can be conducted examining the effects of mind games on the mathematical skills of primary school students. In addition, the cognitive, social, and emotional development of students who have experienced mind games can be examined in detail and in-depth. Another limitation is related to data collection tools. The data of the research was collected through interviews and observation and is limited to these data collection tools only. In research on this subject, researchers can reach more detailed findings by diversifying the data.

Although this research has some limitations, it contributes to the existing mathematics education literature by providing a detailed description of the use of mind games in mathematics teaching. Classroom teachers and mathematics educators should take into account that mind games used in mathematics teaching contribute to students' meaningful and permanent learning, support problem-solving skills, and positively affect the attitude toward mathematics lessons. Therefore, supporting the mathematics teaching and learning process with mind games by classroom teachers can support student learning.

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Informed Consent: In this study, written informed consent was obtained from the classroom teachers in the study group.
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