The Effect of Mangala, the Intelligence Game Taught by Distance Education, on the Mathematical Motivations and Problem-solving Skill Levels of 6th-Grade Students

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Abstract

This study examines the effect of "Mangala" on the mathematical motivation and problem-solving skill levels (PSoSL) of 6th-grade students. A single-group pre-test-post-test quasi-experimental design based on the quantitative research approach was used in the study conducted through distance education. The sample consisted of 14 6th-grade students. The data collection tools used in the study, which continued for three weeks in the 2020-2021 academic year, were the Mathematical Motivation Scale (MMS) and Performance Tasks (PT). The data obtained from this study were analyzed using the SPSS 22.0 package program. Since the sample size was small and the data did not show normal distribution, data analysis was carried out using the Wilcoxon Signed Rank Test, one of the non-parametric statistical tests. Data analysis showed a statistically significant difference between the pre and post-experiment MMS scores of the students. The effect of "Mangala" on students' PSoSL was evaluated through performance tasks. The Progressive Scoring Scale (PSS) taken from Baki (2014) was used to evaluate performance tasks. Researchers redefined each criterion in the scoring key and set four levels: "very good," "good," "unsatisfactory," and "empty." The analysis of the problems in the performance tasks showed that the students usually gave "very good" and "good" answers. However, some students had difficulties finding solution strategies and writing a similar problem; thus, they left blank answers.

Keywords: Mangala, distance education, mathematical motivation, problem-solving skill level, performance task

1. Introduction

Distance education is a model in which teachers and students do not have to be in the same places (National Center for Education Statistics [NCES], 2008), and education activities are carried out through information and communication technologies (İşman, 2011). In the distance education process, students and teachers are physically in separate environments, and they connect with teaching resources and each other through various interactive communication technologies (Simonson, Smaldino, Albright, & Zvacek, 2012).

In distance education models, vast audiences can receive the necessary training from wherever they want, whenever they want. This situation offers various possibilities for individuals who do not have the opportunity to receive education, especially for the courses that cannot be done face-to-face in formal education during the current Covid-19 pandemic to be performed online. Some of them are repeating the courses asynchronously over the internet and at the desired time and conducting exams by distance education. In addition, the opportunity to repeat the teaching subjects more than once and the higher number of exams make distance education efficient (Dinçer, 2006).

In distance education, two-way communication between the teacher and students and meeting students' needs is essential. Besides, in distance education, students should take responsibility for their learning, be determined, and be more active in the process (Moore, 1989). According to Holmberg (1997), active participation in the lesson and learning environments gives the student a sense of belonging, establishes a comfortable communication with the teacher, and makes learning more enjoyable. Therefore, learning pleasure and

participation in decision-making processes have positive reflections on student motivation. One of the active learning methods in which the student is active and willingly participates in the learning environment is learning with games. Games are indispensable activities present in every period of life and used in different situations and purposes (Uğurel & Moralı, 2008). Studies show that game increases individual's motivation (Rosas, Nussbaum, Cumsille, Marianov, Correa, Flores, Grau, Lagos, López, López, Rodriguez, & Salinas, 2003) and concentration (Garris, Ahlers, & Driskell, 2002) and contributes to developing a positive attitude towards learning. (Lou, Abrami, & D'Apollonia, 2001). One of the types of intelligence games that can be used in teaching mathematics is strategy games. Strategic intelligence games are defined as "games in which two or more players play competitively against each other, the decisions they make in the game affect the course and outcome of the game, the opponent's moves should be taken into account in the decisions taken, and there is a winner and a loser at the end of the game" (Erdoğan, Eryılmaz Çevirgen & Atasay, 2017).

Many intelligence games are based on the adaptation of mathematical objects, facts, problems, and concepts (Pintér, 2010; Silva, 2011), which strengthens the belief that there is a close relationship between intelligence games and mathematics (Erdoğan, Eryılmaz Çevirgen, & Atasay, 2017). Understanding mathematical knowledge and establishing a relationship between these pieces of knowledge occurs in the problem-solving process (Swings & Peterson, 1988); thus, problem-solving is at the center of mathematics teaching programs (Karataş & Güven, 2003). Therefore, problem-solving is an essential component of doing math. It is necessary to face students with various problem situations and help them develop solution strategies to improve their problem-solving skill levels (PSoSL). Kurbal (2015) reported that intelligence games improved 6th-grade students' problem-solving strategies, and the students found the games entertaining and valuable. Karasar (2003) expresses every situation that disturbs the individual physically or mentally, gives indecision, and has more than one possible solution as a problem. Different researchers have defined various problem-solving steps. However, the most used problem-solving process in mathematics is Polya's (1957) four-step problem-solving process. Understanding the problem is the first step in this process. The second step is devising a plan suitable for the problem. The third is carrying out the plan or solution strategy. The fourth step is looking back-checking and interpreting. Writing a similar problem is considered a separate stage of the looking back step. Polya (1957) suggested many strategies for solving routine and non-routine problems. For example, pattern search, strategies aiming to focus on the relationship between what is given in the problem and what is asked, and creating tables aiming at systematic thinking and reasoning. According to Polya, strategy knowledge and its use are essential in solving problems. However, what is more important is providing students with the proficiency/competence of strategic thinking. Strategic intelligence games require coming out of a problem situation as a winner, accomplishing a task before the opponent, and establishing some cognitive schemes to perform all these operations systematically (Erdoğan, Eryılmaz Çevirgen, & Atasay, 2017). From this, it is understood that there is a strong relationship between problem-solving and strategic games. One of the intelligence games that require strategic thinking is "Mangala," a traditional Turkish intelligence and strategy game that includes strategic thinking, analysis, and foresight and can be played by players of all ages (see Figure 1). Mangala provides players with social skills, fine motor development, and concentration for children (Uluışık, 2018; Özkaya, 2021). Zaslavsky (1979) states that "Mangala" contributes to the development of mathematical thinking, high-level strategic thinking, and problem-solving skills (Zaslavsky, 1979, cited in Ismael, 2001).

1.1 How to Play Mangala?

Mangala is a traditional strategy game played in different ways (Musesti, Paolini, & Reale, 2015). It is usually played with two people on a game board containing 12 small pits, 2 large pits (treasure), and 24 stones at the zone of each player. At the beginning of the game, four stones are placed in each small pit. The player who starts the game takes four stones from one of the small pits in his/her area and drops one stone back into the pit from which he/she took it. Then he/she continues to the right (counterclockwise) by dropping one stone into each pit until he/she runs out of stone. The player leaves a stone while passing across his/her treasure but does not drop when passing across the opponent's treasure. If the last stone in the player's hand falls into his/her treasury, he/she has the right to play another turn. If the player who distributes the stones has stones remaining in his/her hand, he/she will pass to the opponent's territory and continue to drop stones in the opponent's pits. In this case, if the player's last stone makes the number of stones in the opponent's pit an even number, he/she takes all stones in this pit and puts them in his/her treasury. Suppose the last stone is put in an empty pit in his/her area, and the opponent has stones in the pit opposite it; then he/she takes both the stone left in the empty pit and the stones in the opponent's pit and put them in his/her treasury. In this case, the turn passes to the opponent. The player who first finishes the stones in his/her area wins all the stones in the opponent's pits. When the player runs out of stone, the turn passes to the opponent. The objective of this game is to collect the most stones in the treasures.

The player with the most stones in his/her treasury wins the first set of the game. The game is usually played over five sets (Küçükyıldız, 2020; Özkaya, 2021).

Figure 1. Mangala Game

In learning and teaching mathematics, affective factors such as interest, attitude, and motivation are as important as cognitive factors (Sönmez, 2010; Uluçay & Güven, 2017). Student motivation is an essential component in improving the quality of education. Motivation is a concept related to how individuals are treated and how they feel about their work (Keenan, 1996, cited in Özdemir & Öner, 2015). According to Adler, Milne, and Stablein (2001), motivation is the degree of continuity of an individual's attempts to take action and achieve his goal. Motivation is a driving force for students to be successful, to work hard at school, and to learn (Martin, 2001, cited in Yaman & Dede, 2007), which shows that it has a significant effect on learning (Glynn, Aultman & Owens 2005; Lumsden, 1994). Being active in the learning process increases students' motivation, and participation in decisions positively affects their value systems, mental structures, and motivations (Batlaş, 2002, cited in Akbaba, 2006).

Considering the positive and significant relationship between motivation and achievement (Akbaba, 2006; Herges, Duffield, Martin, & Wageman, 2017; Moenikia & Zahed Babelon, 2010), ensuring student motivation towards mathematics courses is crucial in the process of learning mathematics. Mathematical motivation is defined as students' willingness to learn mathematics and their active participation in mathematical tasks (İspir, Ay, & Saygı, 2011). Motivated students are attentive; they start working on their tasks, ask questions, give voluntary answers, and seem happy and eager (Palmer, 2007).

Ensuring student motivation in the classroom is an essential component in learning (Ersoy & Başer, 2010). If the teacher designs practical learning tools for students and uses classroom activities with appropriate strategies and methods, students' interest in learning will increase (Rifandi, 2013).

1.2 The Significance of the Study and its Contribution to the Literature

In the 21st century, where science and technology are developing rapidly, teaching offers various alternatives. One of them is distance education. Especially in the last two years, the Covid-19 pandemic, which has affected the world, has imprisoned people in their homes and made the distance education alternative mandatory.

As the affective factors are as important as cognitive factors in learning, the motivation of students who cannot attend school and who are deprived of the classroom atmosphere should be increased. Motivation, which can be defined as the willingness to work and participation in the tasks, is one of the affective factors. According to Palmer (2007), motivated individuals are attentive, and they try to fulfill their duties in the best way, ask questions, participate in studies willingly, and appear happy and eager. To motivate their students towards learning is crucial for the teachers, who are one of the essential components of the teaching-learning environment, to increase the quality of teaching. The task of teachers is not only to know what motivates their students but also to help them enhance and improve their motivation and prepare motivational situations.

One of the main objectives of the Mathematics Curriculum is to develop students' PSoSL. For this reason, problem-solving is at the center of the curriculum. In the light of studies on distance education in the literature, it was thought that there might be a positive and significant relationship between students' mathematical motivation and PSoSL, which is one of the basic skills of the 21st century. In addition, there is no study in the literature on the reflection of teaching and playing "Mangala," a strategic intelligence game, through distance education on 6th-grade students' mathematical motivation and PSoSL. Thus it was decided to conduct this study. Besides, this study was carried out with the idea that games can be used to increase motivation towards mathematics lessons in the distance education process. The study aimed to teach and play the strategic game "Mangala" and determine its effect on students' mathematical motivation and PSoSL. In addition, the significance of the relationship between mathematical motivation and PSoSL was investigated. Therefore, the

original value of the study lies in its purpose. In this context, it is thought that this study will contribute to the literature.

1.3 The Purpose of the Study and Research Problems

This study aims to examine the effect of "Mangala," taught by distance education, on 6th-grade students' mathematical motivation and PSoSL and investigate whether there is a statistically significant relationship between mathematical motivation and PSoSL. In this direction, the sub-problems addressed in the study are as follows:

1) Does "Mangala," taught by distance education, create a statistically significant difference between 6th-grade students' pre and post-test mathematical motivation scores?
2) What are the PSoSL of 6th-grade students learning and playing "Mangala" through distance education?
3) Is there a statistically significant relationship between PSoSL and the mathematical motivations of 6th-grade students?

2. Methodology

2.1 Research Design

Qualitative and quantitative approaches were used together in the study. The research design was set as a single-group pre-test post-test weak quasi-experimental design. In a single-group pre-test post-test design, the independent variable is implemented, and measurement is made before and after the implementation (Karasar, 2003). In the study, the quantitative approach was used to analyze the data that measured students' mathematical motivation using non-parametric tests and determine whether there is a statistically significant difference between mathematical motivation and PSoSL. Besides, the qualitative approach was employed by using descriptive analysis to determine PSoSL.

2.2 Study Group

This study was conducted with 14 students attending 6th-grade of a public school in the Marmara Region of Turkey in the 2020-2021 academic year. The socio-economic levels of the students participating in the study were moderate, and all of them have participated voluntarily. Instead of the students' real names, codes such as S1, S2,…, S14 were used.

2.3 Data Collection

In the study, MMS was used to measure students' mathematical motivation and PTs to determine PSoSL.

2.3.1 MMS

MMS, developed by Üzel, Uyangör, Damage, and Çakır (2018), was administered to measure the mathematical motivation of the students participating in the study before and after the implementation. The Cronbach alpha reliability coefficient of the scale was .88. The scale consisted of 26 five-point Likert type items scored as "I totally agree, agree, undecided, disagree and totally disagree." 18 of the items were positive, and 8 were negative.

2.3.2 PT

Two performance tasks (see Appendix A), related to the gains given in the 6th-grade Mathematics Curriculum (MoNE, 2018), have been prepared to examine the effect of "Mangala" on students' PSoSL.

1) Writing the algebraic expression of a verbally given problem and the verbal expression of a given algebraic problem.
2) Calculating the value of algebraic expressions for the natural numbers that the variable will take. Explaining the meaning of simple algebraic expressions.

The data obtained from the application aimed at determining students' PSoSL were analyzed with descriptive analysis, one of the qualitative data analysis techniques. Polya (1957) describes the problem-solving process as a four-step process: understanding the problem, devising a plan for solving the problem, carrying out the plan, and looking back/evaluating the solution. Gonzales (1998), on the other hand, suggested adding another step that he expressed as problem-posing or problem writing to Polya's problem-solving process. In this study, descriptive analysis was conducted using the five-step "Progressive Scoring Scale (PSS)" taken from Baki (2014) in line with the framework suggested by Polya (1957) and Gonzales (1998). The five steps of PSS (see Appendix B) were scored as 3, 2, 1, and 0, going from the highest to the lowest performance. The researchers made a new scoring to determine the students' PSoSL by adhering to the original PSS, which they used to analyze qualitative data. Accordingly, 3-point performance was defined as "very good," 2 as "good," 1 as "unsatisfactory," and 0 as

"blank." They prepared two performance tasks (problems) to determine students' PSoSL. The opinions of an expert and a secondary school mathematics teacher were taken regarding the suitability of the problems in terms of content, level, and language to ensure content validity. The problems were then revised and conducted on three students as pilots. Afterward, the problems were finalized, and they were administered to the experimental group in 40 minutes. The guideline prepared to answer performance tasks is included in Appendix C.

2.4 Data Analysis

Quantitative and qualitative data obtained in the study were analyzed using appropriate analysis methods. Accordingly, the quantitative data were analyzed using the SPSS 22.0 package program. Wilcoxon Signed Rank Test, one of the non-parametric analysis techniques, was used to analyze the data. Wilcoxon Signed Rank Test was used to determine whether students' mathematical motivations differed with the teaching and practice/playing of "Mangala." Wilcoxon Signed Rank Test is primarily used in researches with a low sample size. This test replaces the t-test in cases where the score differences do not show normal distribution; the scores were obtained from the same subjects at different times (Büyüköztürk, 2006, 163). In this study, non-parametric statistical methods were used to analyze the data because the data did not show normal distribution, and the sample size was small. The correlation method was used to examine the relationship between students' PSoSL and mathematical motivation. The correlational analysis describes the relations between two or more variables (Büyüköztürk et al., 2010; Franenkel, Wallen, & Hyun, 2012). In this study, this method was preferred because it was aimed to reveal the relationship between students' PSoSL and mathematical motivation.

The analysis of the data obtained from the application determining students' PSoSL was made with descriptive analysis, one of the qualitative data analysis techniques. In the descriptive analysis, the data is first described systematically and clearly according to the predetermined themes. These descriptions are then interpreted, and some results are reached through cause-effect relationships (Yıldırım & Şimşek, 2018). In this study, the descriptive analysis has been performed in line with the framework suggested by Polya (1957) and Gonzales (1998), using the five-step "PPS" taken from Baki (2014); the scores of problem-solving steps were redefined as "very good, good, unsatisfactory and empty" by the researchers. Two researchers scored the problems given as performance tasks according to redefined levels, and the agreement between coders was calculated following the Miles and Huberman formula (1994). The agreement was found to be 85%. The researchers re-evaluated the data together for the remaining 15%, reached a consensus, and achieved 100% agreement. The levels of the answers given to problem-solving steps that researchers redefined by adhering to PPS to determine the students' problem-solving levels are as follows:

Very good: Understanding the problem completely, choosing the appropriate solution strategy, making the right solution, evaluating the solution logically, posing and solving a logical and solvable similar problem.

Good: Understanding the problem, choosing the appropriate solution strategy, solving the problem with some minor mistakes, verifying the result logically, and posing a problem by only changing the values in the problem.

Unsatisfactory: Failure to understand the problem, choosing only part of the appropriate solution strategy, solving the problem inappropriately and incorrectly, verifying the results partially, and posing a similar problem with logical error.

Empty: No effort has been made to understand the problem, no strategy has been chosen, the problem has not been solved, failure to know how to verify the result, and either the same problem has been posed, or no problem has been written.

The second sub-problem of the study, "What is the PSoSL of 6th-grade students who learned and played "Mangala" through distance education?" was addressed using these levels. Since an in-depth review of the PSoSL data is intended, a descriptive analysis was conducted using the qualitative approach, and the second sub-problem was addressed. Secondly, this data was treated quantitatively and used in correlation analysis to understand whether there is a statistically significant relationship between students' mathematical motivation and PSoSL. For the reliability of the study, two researchers scored PSoSL separately, and the agreement rate was calculated according to the Miles and Huberman formula (1994). The agreement rate was found to be 85%. For the 15-point difference, the researchers made a re-evaluation together, reached a consensus, and achieved a 100% agreement. After scoring according to the determined levels, the SPSS 22.00 program was used to determine whether there is a statistically significant relationship between the students' PSoSL scores and the scores they got from MMS.

2.5 Implementation Process

This study was conducted online in the spring semester of the 2020-2021 academic year and lasted three weeks.

The experimental group was the only group in the research, and the lessons continued following the existing Teaching Mathematics Program (MoNE, 2018) based on the constructivist approach. Students participated in all mathematics lessons throughout the process. Before starting the implementation, students were interviewed individually to understand whether they knew "Mangala." 7 students familiar with the game were excluded from the study, and the remaining 14 students were included. Students' mathematical motivation was measured by the Mathematical Motivation Scale (MMS), administered as the pre-test and post-test. Since the study was online, the MMS, consisting of 26 items, was prepared in Google Forms, the address link was sent to the students, and all students filled the scale. Students could answer the form only once; they were prevented from submitting more than one answer. The students were asked to write their names while filling the scale, and they were informed that the given answers would not be used in any other place than this scientific study. Students participated in the "Mangala" activity three days a week and the mathematics lessons in the weekly program during the implementation process. "Mangala" was taught to students by their mathematics teacher, who was also one of the researchers of this study. Then, students were left to play the game interactively from the "Mangala" game application that they downloaded to their phones or tablets. The activities carried out in the implementation process are given in Table 1.

Table 1. The activities carried out in the implementation process

Activities	1st week	2nd week	3rd week
Pre-test (MMS)	✓		
Teaching "Mangala"	✓	✓	
Playing "Mangala"	✓	✓	✓
Post-test (MMS, PT)			✓

1st week: Students were informed in detail about the process. MMS was administered as the pre-test. After collecting the pre-test data from all students, the implementation was started. Previously prepared slides and videos about "Mangala" were shown to the students. Then the researchers answered the students' questions by explaining the history, purpose, and rules of the game in detail. Each student downloaded the game called "Mancala" to their phone or computer, and for three days, students were left to play the game both in online classes and outside the class. Students were asked to share screens during the lesson. Each student was monitored at least once by their teachers and other students, and the mistakes made were corrected. Students played the game as much as they wanted without any limitations.

2nd week: Considering the mistakes students made while playing "Mangala" in the first week, the details of the game were explained again. They were left to play the game for another three days.

3rd week: Students continued to play "Mangala" for three days in the 3rd week. The performance tasks prepared to determine students' PSoSL were reflected on the screen in the last lesson. All students were asked to answer the questions on the paper within the given time. They then took pictures of their answers and sent them to their teachers at the end of the lesson. All students' answer sheets were sent. Then, MMS was administered to students as the post-test, and the implementation process ended after collecting all answers.

3. Results

In this section, the findings obtained from the analyzes carried out to reveal the effect of "Mangala," which was played three days a week for three weeks outside the lessons in addition to the mathematics lessons instructed according to the current Teaching Mathematics Program (MoNE, 2018), on the mathematical motivation of students, whether there is a statistically significant relationship between their mathematical motivation and PSoSL and to determine the level of their PSoSL.

3.1 Findings on the First Sub-Problem and Discussion

The first sub-problem of the research was "Does "Mangala" taught by distance education create a statistically significant difference between pre and post-test MMS scores of 6th-grade students? The pre-test and post-test data obtained from MMS were analyzed using the Wilcoxon signed-rank test. Analysis results are given in Table 2.

Table 2. Wilcoxon signed ranks test results for MMS scores

Pre-Test- Post-Test	n	Mean Rank	Sum of Ranks	z	p
Negative Rank	0	.00	.00	3.30	.001
Positive Rank	14	7.50	105.00		
Same Rank	0				

The analysis results show a significant difference between the pre and post-experiment scores of the students participating in the research (z=3.30, p<.05). Regarding the mean rank and sum of the ranks, this observed difference is in favor of the post-test. According to this result, it can be said that "Mangala" has a significant effect on increasing students' mathematical motivation.

3.2 Findings on the Second Sub-Problem

The second sub-problem of the research was "What is the PSoSL of 6th-grade students playing "Mangala" taught by distance education?" In the analysis, the performance tasks were first scored regarding students' performance at each problem-solving step. Tables indicating the number of students at each level were prepared and interpreted. Then, direct quotations from the answers of the students were taken., PSoSL is determined according to the performance scores obtained from problem-solving steps; they are shown together with the number of students in Table 3.

Table 3. Students' PSoSL and total performance scores

		Performance Task 1				Performance Task 2			
		Number of students				**Number of students**			
		(total performance scores)				**(total performance score)**			
	PSoSL and Performance Scores	Very good (3)	Good (2)	Unsatisfactory (1)	Empty (0)	Very good (3)	Good (2)	Unsatisfactory (1)	Empty (0)
Problem-solving steps	**Criteria**								
Understanding the problem	Expressing the problem in own words	9(27)	2(4)	-	3(0)	9(27)	1(2)	1(1)	3(0)
Devising a plan	Writing what is given and asked in the problem	9(27)	2(4)	-	3(0)	10(30)	1(2)	-	3(0)
	Modeling the problem	5(15)	2(4)	2(2)	5(0)	4(12)	3(6)	2(2)	5(0)
	Identifying the solution of the problem	5(15)	3(6)	1(1)	5(0)	5(15)	2(4)	2(2)	5(0)
Carrying out the plan	Solving the problem by following the rules	12(36)	-	-	2(0)	12(36)	-	-	2(0)
Looking back	Checking the correctness of the result	12(36)	-	-	2(0)	11(33)	-	1(1)	2(0)
	Interpreting the result and drawing conclusions from the problem	10(30)	-	2(4)	2(0)	11(33)	1(2)	-	2(0)
Suggesting/posing a similar problem	Posing a similar problem	8(24)	2(4)	-	4(0)	7(21)	3(6)	-	4(0)
and solving it	Solving the posed similar problem	8(24)	2(4)	-	4(0)	6(18)	4(4)	-	4(0)

-: There are no answers in the relevant criterion.

Regarding Table 3, some students failed to answer the questions in the given performance tasks at each problem-solving step. The students who could not answer failed to develop a strategy for solving the problems in both performance tasks, and they were not successful in posing and solving a similar problem. Again, from Table 3, the number of students who responded unsatisfactorily to the performance tasks is relatively low. These students have difficulties creating a strategy for the problem, posing a similar problem, and solving it. As shown in Table 3, most of the students produced very good and good solutions to the problems. An interesting result

emerging from the "very good" performance level of Table 3 is that the number of students who answered solving the problem and checking the correctness of the solution steps was higher than the number of students who answered understanding the problem and devising a plan steps. The reason behind it might be that when students encounter a problem, they want to solve it by directly focusing on the solution. In the one-to-one interviews, these students expressed the problems with their own sentences and explained their solution strategies. This fact can also be seen in direct quotations from students (see Figure 2).

Table 4 was created to understand better the data obtained from this research. Firstly, the minimum and maximum scores that can be achieved from each step were calculated. Accordingly, the maximum possible score of each performance level is determined by multiplying "number of problem-solving steps x performance score x number of students." For example, the highest performance score that can be achieved for the "Very good" level is calculated as follows. Problem-solving consists of 5 steps. The score of very good is 3. The number of students in the study is 14. Therefore, the highest performance score that can be obtained for the "Very good" level is 5x3x14= 210. In Table 3, each problem-solving step is defined with different numbers of criteria. In Table 4, the total score of the step is divided by the number of criteria to get a single score. Since the maximum score of the "blank" level is 0, it is not included in Table 4.

Table 4. Averages of students' total performance scores and PSoSL

Problem-solving steps	0 ≤ performance score of very good level≤210, 0≤ performance score of good level ≤140, 0≤ performance score of unsatisfactory level ≤70					
	PT1 and PSoSL Averages of performance scores for each level of each step			PT2 and PSoSL Averages of performance scores for each level of each step		
	Very good (3)	Good (2)	Unsatisfactory (1)	Very good (3)	Good (2)	Unsatisfactory (1)
Understanding the problem	27:1=27	4:1=4	-	27:1=27	2:1=2	1:1=1
Devising a plan	(27+15+15):3=19	(4+4+6):3=4,66	(2+1):2=1,5	(10+14+5):3=6,33	(1+3+2):3=2	(2+2):2=2
Carrying out the plan	36:1=36	-	-	36:1=36	-	-
Looking back	(30+36):2=33	-	4:1=4	(33+33):2=33	2:1=2	-
Posing&solving a similar problem	(24+24):2=24	(4+4):2=4	-	(21+18):2) =19,5	(6+4):2=5	-
Total Perfoemence Score	139	12,66	5,5	121,83	11	3

Since there is more than one criterion in the "devising a plan," looking back," and "posing&solving similar problem" steps of problem-solving, the averages of the scores achieved at these steps are shown in Table 4. The scores obtained from each performance task at each level can be seen in Table 4. Accordingly, most of the students gave very good and good answers. Two performance tasks were given to the students to determine their PSoSL. The average performance task scores were calculated, the ratio of total performance scores to the maximum possible score was taken, and Table 5 was created.

Table 5. Average scores that students get from performance tasks and their ratio to the maximum possible score

PSoSL	Very Good	Good	Unsatisfactory
(PT1+PT2):2=average score	130.41	11.83	4.25
%	62.1	8.45	6.07

Regarding Table 5, the majority of the students gave very good answers. It can be said that the students achieved significant success by getting 62.1% of 210, which is the highest performance score that can be obtained from the "very good" level.

Direct quotations from students' answers for each problem-solving step are shown in Figures 2, 3, 4, 5, 6, 7, and 8.

In Figure 2, students answered the question "express the problem in your own words" with expressions such as

"Find 8 more than 3 times", "short edge," and "We will find an algebraic expression in the problem and calculate it with the given values." These students' answers show that they failed to fully express the problems in their own words and focused on devising a plan. However, in the interview with these two students who gave these answers, they expressed the problem verbally in their own words; therefore, their performance was evaluated as good.
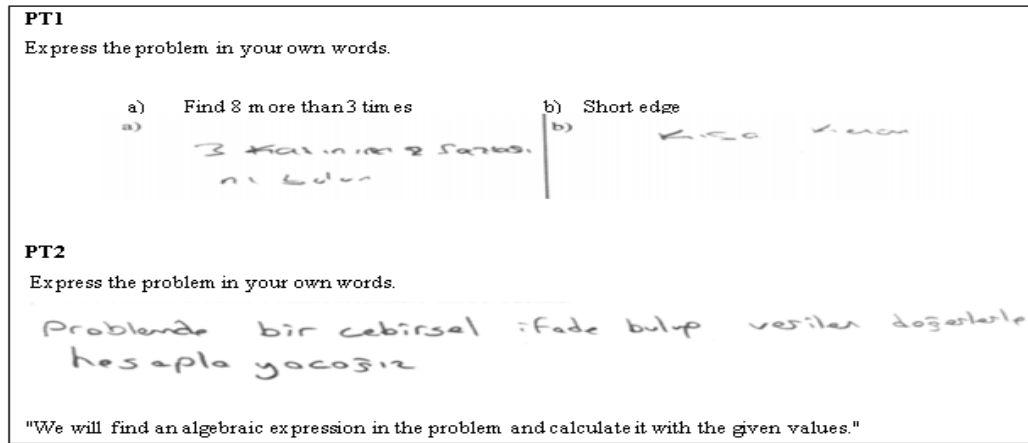

Figure 2. Student answers for the "understanding the problem" step evaluated as "good."

In Figure 3, the student's answers at "devising a plan" step were "asked = find the algebraic expressions expressing the short side., given: all students attend the lesson." and "asked = write the algebraic expressions verbally. given= short side, x long side 3x+5". The student's performance levels in PT1 and PT2 were evaluated as unsatisfactory because one student could not write what was given and asked, and the other did not make any explanations.

Figure 3. Student answers for the "devising a plan" step evaluated as good and unsatisfactory

In Figure 4, the students were asked to make mathematical modeling for the "devising a plan" step of problem-solving. However, the student who answered PT1 could not model the problem correctly because he failed to properly use the number, unknown, and variable concepts. Therefore, this student's answer was evaluated as unsatisfactory. The student who answered PT2, on the other hand, was evaluated as very good because he did the modeling correctly.
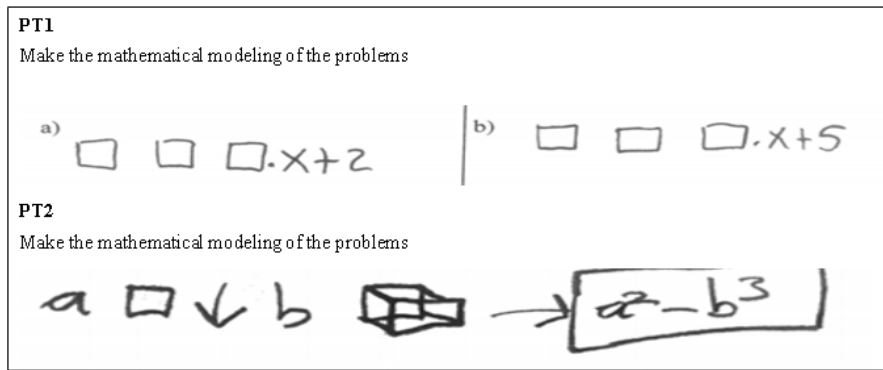
Figure 4. Student answers for the "devising a plan" step evaluated as unsatisfactory and very good

In Figure 5, students who answered PT1 and PT2 solved the problems correctly. Therefore, the answers of these students were evaluated as very good.
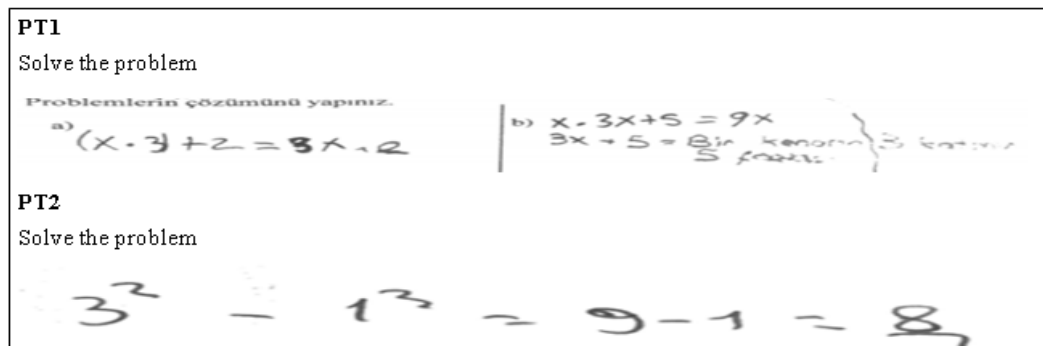

Figure 5. Student answers for the "carrying out the plan" step evaluated as very good

In Figure 6, the student who answered PT1 lacked knowledge about the order of operations and therefore could not check the correctness of the solution of the given problem. This student's answer was evaluated as unsatisfactory. The student who answered PT2 in Figure 6 did make no explanation while checking the correctness of the solution and solved the problem again: therefore, this student's answer was evaluated as good.
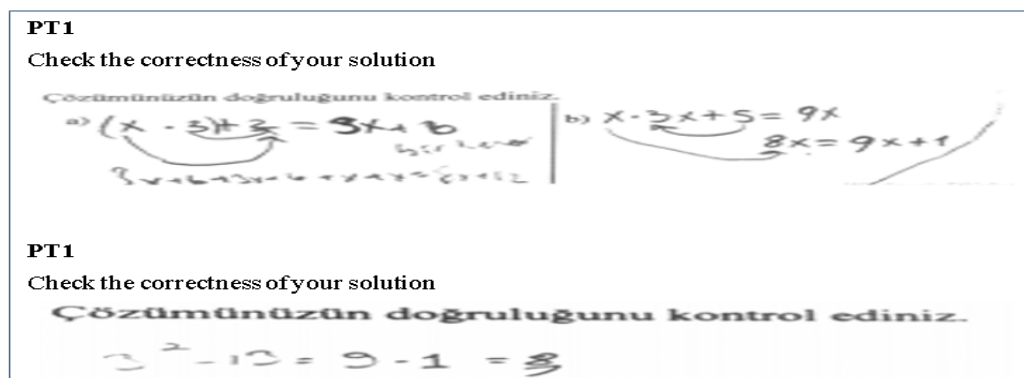

Figure 6. Student answers to the "looking back" step evaluated as unsatisfactory and good

The answers of the students who were asked to pose and solve a similar problem in PT1 and PT2 are shown in Figure 7. The student could not pose a problem similar to PT1 and therefore could not solve it; on the other hand, another student who answered PT2 posed a similar problem and solved it.
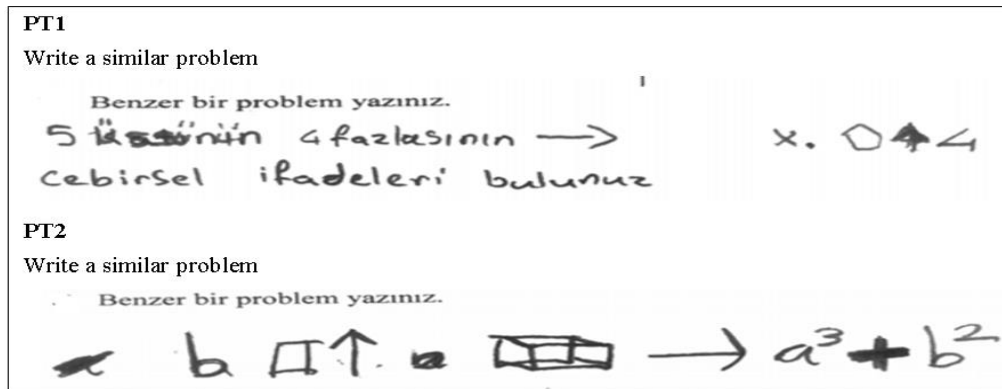
Figure 7. Student answers to the "suggesting/posing and solving a similar problem" step evaluated as unsatisfactory and good

3.3 Findings on the Third Sub-Problem

The third sub-problem of the study was expressed as "Is there a statistically significant relationship between PSoSL and the mathematical motivations of 6th-grade students?"

Correlation analysis was conducted to determine whether there is a statistically significant relationship between students' scores from MMS and PSoSL. Non-parametric tests were used because the sample size was small, and the data did not show a normal distribution. Spearman-Brown Rank Differences method was used, and Spearman's rank correlation coefficient was calculated to explain the relationship between the two variables. Table 6 contains the findings obtained from the correlation analysis.

Table 6. The Results of Spearman Correlation Analysis between MMS and PSoSL

Variables		MMS	PSoSL
MMS	r	1	.794*
	p		.001
	N	14	14
PSoSL	r	.794*	1
	p	.001	
	N	14	14

*: Correlation is significant at 0.01 level (2-tailed). PSoSL: Problem-solving skill level, MMS: Mathematical Motivation Scale,

r: Spearman's Correlation Coefficient

Regarding Table 6, there is a strong, positive, and significant relationship between MMS and PSoSL (r=.794, p<.05). Based on this result, it can be said that there is a high level, positive and significant relationship between students' mathematical motivation and PSoSL. In this study, which has been conducted with a single-group quasi-experimental design, it can be said that students' learning and playing "Mangala" through distance education increased their mathematical motivation based on the findings of the first sub-problem. In addition, it seems possible to state that the increase in students' mathematical motivation was positively reflected in their PSoSL.

4. Discussion and Conclusion

This study investigated the effect of teaching and playing "Mangala" through distance education on 6th-grade students' mathematical motivations and PSoSL and the relationship between them. As a result, a significant difference was found between students' pre- and post-experiment MMS scores. Based on this result, it can be said that "Mangala" increased the mathematical motivation of 6th-grade students.

This study's second sub-problem was set as examining PSoSL of 6th-grade students who played "Mangala," taught through distance education. The results of data analysis showed that the number of students who answered the performance tasks (prepared to determine students' PSoSL) as unsatisfactory is relatively low. Besides, these students had difficulties devising a plan for the solution and posing and solving a similar problem. On the other

hand, most of the students gave very good and good answers to the performance tasks. They were able to solve the problems by applying their own plans and strategies. The majority of the students achieved significant success by getting 62.1% of the 210 points, the highest score that can be achieved for the very good level. On the other hand (see Table 3), an interesting result emerged in the very good performance level: the number of students who answered solving the problem and checking the correctness of the solution steps was higher than the number of students who answered understanding the problem and devising a plan steps. It may be because students tend to solve the problem by directly focusing on the solution when faced with a problem. In one-to-one interviews with these students, they expressed the problems with their own sentences and explained their solution strategies. It is recommended to conduct qualitative studies investigating the reasons for this situation.

The study results of Karayol and Temel (2018) on the game and PSoSL were similar to this study. Karayol and Temel (2018) reported that structured games are effective in reaching the target. Similarly, Kurbal (2015) reported that intelligence games improved the problem-solving strategies of 6th-grade students and that the students found the games entertaining and valuable. According to Zaslavsky (1979), "Mangala" contributes to the development of PSoSL (as cited in Ismael, 2001). Zaslavsky's (1979) view supports the results of this study.

The definitions of the game (Biriktirir, 2008; Demirel, 2006; Öztürk, 2007) reveal that the game is an active learning process, effective in the physical, cognitive, emotional, and social development of the child and children take part willingly and voluntarily. In learning with games, games appeal to more than one sense organ and encourage communication between students. Therefore, students can produce many ideas and act higher (Seo, 2003, cited in Kaya & Elgün, 2015). Studies involving teaching with games have increased student achievement, motivation, and performance (Aksoy, 2014; Kaya & Elgün, 2015; Randel, Morris, Wetzel, & Whitehill, 1992; Romine, 2004, Usta et al., 2018). According to Randel et al. (1992), an entertaining classroom environment increases students' motivation throughout the course, strengthens their performance, and helps them understand mathematical knowledge better. The results of this study, in which Mangala teaching increased the mathematical motivation of 6th-grade students, and the results of Randel et al.'s (1992) and Romine's (2004) are similar in this context. Schweinle, Meyer, and Turner (2006) found that the effective feedback of the teacher, explaining the concepts, social relations, and cooperation, supporting student autonomy, and focusing on the learning process increased student motivation.

As a result of the correlation analysis performed to answer the third sub-problem of the study, a strong, positive, and significant relationship was found between MMS and PSoSL (r=.794, p<.05). According to this result, it can be said that there is a high level, positive and significant relationship between students' mathematical motivation and PSoSL. Students' learning and playing "Mangala" through distance education increased their mathematical motivation, and this result is significantly, positively, and highly correlated with their PSoSL.

This study has shown that using "Mangala" in the teaching process positively affects the mathematical motivation of 6th- grade students. The intrinsic characteristics of "Mangala," such as struggle, belonging to a group, the will to win, and the game format, may have been effective in the emergence of this result. It is possible to offer more active and entertaining learning environments for students by using "Mangala."

5. Suggestions

During the current Covid-19 epidemic, teaching via distance education has become inevitable. Mathematics lessons, which students perceive as abstract and complex, created considerable stress on most students, especially in this period, due to the accumulation of different reasons. This study showed that "Mangala" effectively increased students' mathematical motivation in the distance education process. In this context, it can be suggested to play "Mangala" and similar games in mathematics classes to increase the mathematical motivation of students, especially in periods similar to the pandemic we live in. The 3-week period was one of the limitations of the study. For this reason, it is recommended for future research to keep the implementation process longer and increase the number of participants. It is suggested to conduct a qualitative analysis for the interesting results of this research that emerged from the measurement of PSoSL. In addition, it is suggested to carry out this study at different grade levels and use experimental designs with control groups.

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Appendix

Appendix A.

Performance tasks prepared to determine PSoSL

DISTANCE LEARNING

6'A class students are taught their courses online during the distance education process. Due to the system's intensity, some students may have problems connecting to the lesson on the same day. The connection status of a class of 12 people to two different lessons on the same day is given below.

Figure 1: First lesson   Figure 2: Second lesson

While all students attended the first lesson, three students had problems connecting to the second one, and only nine students attended the second.

a) Students attending the first lesson see each other on the screen. Under this condition, regarding the image on the screen of a student attending the first lesson, if the length of the long side is 2 more than 3 times the length of the short side, write the algebraic expression that gives the length of the long side of the screen image.

b) Students attending the second lesson see each other on the screen. Under this condition, regarding the image on the screen of a student attending the second lesson, if the length of the short side is x units and the length of the long side is 3x+5 units, verbally express the algebraic expression that gives the length of the long side of the screen image.

RESFEBE CONTEST

Büşra teacher is playing the resfebe game with her 6th-grade students. The definition and explanations of the resfebe game are given below.

Resfebe is an intelligence game based on finding an expression by combining letters, numbers, and pictures. küp=cube, artma=increase, kare=square

Büşra teacher wrote the following resfebe on the board.

Construct the algebraic expression for the given resfebe and calculate its value for a=3, b=1

Appendix B

Progressive Scoring Scale

Problem		
A		*Understanding the Problem*
	3	Understanding the problem entirely
	2	Understanding some points of the problem
	1	Being not able to understand the problem
	0	Not showing any efforts to understand the problem
B		*Devising a Plan (Choosing a Strategy)*
	3	Choosing a strategy that can lead to an appropriate solution
	2	Choosing only one part of strategy that can help solution
	1	Choosing an inappropriate strategy
	0	Not choosing any strategies
C		*Carrying Out the Plan*
	3	Finding suitable and correct solution
	2	Finding a solution which is partly correct
	1	Finding a solution which is inappropriate and incorrect
	0	Not being able to find any solutions
D		*Looking Back*
	3	Solving the problem and newly created problem based on it
	2	Verifying the results reasonably
	1	Verifying the results partially
	0	Not knowing how to verify the results
E		*Suggesting a Problem*
	3	The problem created is reasonable and solvable
	2	A new problem has been created by changing values of the problem
	1	The problem created is unreasonable and unsolvable
	0	The same or new problem has not been suggested

Appendix C

The Guideline Prepared for Answering Performance Tasks

Performance tasks prepared to determine PSoSL were answered according to the instructions below.

a. Express the problem in your own words.

b. What is given in this problem? What is asked?

c. Explain how you are going to solve this problem.

d. Solve this problem.

e. Check the result you have found. Is it correct? If not, what mistakes have you made? Explain your answer.

f. Write a similar problem and solve it