Education Mind

EDUCATION MIND
2023, VOL 2, NO 1, 1-15
DOI: 10.58583/Pedapub.EM2301

Research Article

Open Access

The effect of mind games activities on problem-solving and computational thinking skills of grade 5 students

Abdullah Güneri [1], Özgen Korkmaz [2]

[1] Department of Instructional Technologies, Amasya University, Amasya, Turkey; [2] Department of Computer Engineering, Amasya University, Amasya, Turkey

ARTICLE HISTORY

Received: 23.03.2023
Received in revised form: 20.04.2023
Accepted: 30.04.2023

KEYWORDS

Mind games
Computational thinking
Problem-solving

CORRESPONDENCE

Özgen Korkmaz,
ozgenkorkmaz@gmail.com

ABSTRACT

This research aims to examine the effect of Mind Games activities on problem-solving skills and computational thinking skills of 5th grade students. Sequential explanatory design, one of the mixed research methods, was used in the research. The research was carried out in a quasi-experimental design pretest-posttest without a control group with 17 5th grade students in a secondary school in Adıyaman. The research was carried out with an experimental period of 6 weeks. Before the experimental study, the problem-solving skills and computational thinking skills scales were applied to the students as a pre-test. Kapsul game activity was performed in the first week of the experimental study. ABC Baglama activity was held during the week. Sudoku activity was held in the 3rd week. In the 4th week, Three Stone game activities were held. Kendoku game activity was held in the 5th week. In the 6th week, Kakuro game activity was held. Statistical values in the study were calculated using the SPSS program. To collect quantitative data, a pre-test of problem-solving skills and computational thinking skills was applied to the students before the experimental process. After the experimental process, problem-solving skills and computational thinking skills scales were applied as a posttest. The applied pre-test and post-test results were analyzed with the paired sample t-test. Additionally, to collect qualitative data to strengthen the research, an interview form was applied to obtain the opinions of the students about the experimental process. In line with the findings obtained because of the experimental study, it can be said that the mind game activities have a positive effect on the students' computational thinking and problem-solving skills, and the lesson turns into more fun.

Introduction

In the developing and rapidly advancing digital age, individuals should respond to the problems and obstacles they face. Simultaneously, there is a need to develop solutions to these problems or obstacles (WEF, 2020). To identify the current problem and overcome the problem situation is the basic expectation of the school, the environment, and the family that the individual is in. The developments in the world, along with the renewal of education systems, should provide new technological life to individuals (Ananiadou, & Claro, 2009). While it is extremely important for individuals to develop cognitive strategies by involving themselves in the solution processes for their own learning processes, it is necessary to realize the problem and see all possible solutions and activate the most economical and permanent solution path from these solutions (Ünsal, & Ergin, 2011). To prepare dynamic individuals who produce permanent solutions, who can produce and adapt information, who can put it through mental filters and reflect it, who can share the information they have obtained; however, who can respond to the expectations of the digital world 21. it is necessary to educate up-to-date, modern individuals who have acquired the skills of a century (Uluyol, & Eryilmaz, 2015). A developed society can be reached with fully equipped individuals with up-to-date knowledge and skills (Toptaş, & Kılıçkaya, 2017).

It is possible to say that among the skills of the 21st century, problem-solving, and computational thinking have recently come to the fore. Çavuş (2004) emphasizes that problem-solving is a stage of adaptation to life and the society in which it occurs. Human beings face different problems throughout their lives. In other words, to live is to struggle with problems. According to Demirtaş and Dönmez (2008), what is important is that an individual has the competence to solve the problems he faces, which increases the importance of problem-solving skills. Daily life activities are also like a problem. It can also be seen as comprehensive problems that need to be solved step -by step (Rahman, 2019). Research conducted on problem-solving skills reveals that problem-solving education positively affects problem-solving skills in individuals (Koray, & Azar, 2008). The tendency of individuals to solve the problems they face throughout their lives makes problem-solving skills important. The more resourceful the individual is in this sense, the easier it is for him to adapt to the environment (Çınar, Hatunoğlu, & Hatunoğlu, 2009). Problem-solving ability is evaluated as the process of reaching a solution by taking advantage of the individual's own knowledge (Temel, & Ayan, 2015).

Although computational thinking skills is one of a 21st century skill, it appears as a problem-solving process in educational environments (Wing, 2011). Computational thinking ability has recently been accepted as a new skill area in the literature (Üzümcü, & Erdal, 2018). According to Korkmaz, Çakır, and Özden (2015), 21st-century students should have some skills. These skills are innovative, creative, researcher, collaborators, problem solvers, critical thinkers, have technological skills, social, cognitive, communication skills, self-management individuals. Based on this, it is seen that computational thinking skills has different and interdisciplinary relationships instead of thinking in a single direction, when looking at the literature, computational thinking skills should be studied as an interdisciplinary subject because it is a structure of thought or a way of thinking (Demir, & Seferoglu, 2017). Computational thinking skills has more than one thinking style and sub-dimensions, and in these sub-dimensions there are forms of thinking such as critical thinking and algorithmic thinking (Tutulmaz, 2019). Computational thinking requires systematic problem-solving, systematic testing, and debugging (Shute, Sun, and Asbell-Clarke, 2017). We can interpret computational thinking skills as related processes formulated against the current problem (Wing, 2006). Computational thinking is the ability to abstract problem situations (Henderson, Cortina, & Wing, 2007). Based on this, we can see the operations that occur in mental processes based on computational thinking skills. All these show that computational thinking skills are related to problem-solving skills. Problem-solving is the ability of an individual to develop and overcome solutions despite an obstacle he faces in life, while computational thinking is the process of analyzing a problem in all its aspects (Bulut & Yilmaz, 2021). To benefit from the changes brought with the rapid development of technology, students will need to learn and implement this new style of computational thinking skills (Gulbahar, Kert, & Kalelioglu, 2019). When the literature was examined, it was tried bringing solutions to the problems of computational thinking skills with the digital tools available with today's technology (Gulbahar, Kert, & Kalelioglu, 2019). Yıldız, Çiftçi, and Karal (2017) argue that it is possible for an individual to perform better in his professional life and to be happy in private and social life by completing his own development. Based on this, in a world where technology is developing and growing rapidly, the increase in individuals with these skills increases productivity and quality standards in production positively. Again, it is assumed that individuals with these skills are important in terms of ensuring the employment of an economy and society with continuity in a competitive environment (Yıldız, Çiftçi, & Karal, 2017).

While research on problem-solving skills in the literature dates to past periods, research on computer thinking skills has been observed recently. The relationship between problem-solving skills with some areas of intelligence at all levels of educational environments (such as emotional intelligence, social intelligence), the relationship with gender, talented students, personality traits, seniority difference, professional groups, problem-solving and reading are seen in the literature. Some of these are: The relationship of problem-solving skills with mathematics achievement (Özsoy, 2005), the problem-solving skills of high school students (Korkut, 2002), the problem-solving skills of teachers (Çınar, Hatunoğlu, & Hatunoğlu, 2009), the relationship between emotional intelligence levels of students and problem-solving skills (Karabulut, Yılmaz, & Yurttaş, 2011), the study of the relationship between university students' personality traits and problem-solving skills (Dündar, 2009). Again, when the research on computational thinking skills in the literature is examined; The effect of programming on computational thinking skills (Sirakaya, 2019); the effect of visual programming on computational thinking skills (Uslu, 2018); the effect of robotic activities on computational thinking skills, Passenger (2018); the effect of gamified robotic activities on computational thinking skills (Mahmure, Korkmaz, & Cakir, 2020) can be found in research such as. The effect of the game-based Scratch program on the fifth-grade students' computational thinking skills was examined in the research (Korkmaz, & Oluk, 2018), and it was determined that these applications significantly contribute more to the students' computational thinking skills.

Although there are studies in the literature that address these skills separately, there have been no studies that address the effects of mind games activities on problem-solving skills and computational thinking skills together. Mind games lessons are taught as an elective course in primary school curricula (TTKB, 2013). There are some games such as verbal games, strategy games, reasoning and processing games, intelligence questions, geometric-mechanical games, and memory games in the mind games course (TTKB, 2013). It is possible to say that games have an important place in making learning environments more fun. In this context, it is stated that computer-based games are especially prominent (Kirriemuir, & McFarlane, 2004). Pepe (2011) emphasizes that children should be allowed to play these games in reasonable environments and durations. It is emphasized that the mind games course is an important lesson for activating algorithmic thinking in an individual, increasing their problem-solving potential and improving their creativity (Aslan, 2019). In a study by Türkoğlu and Uslu (2016), it is stated that the "Game-Based Cognitive Development Program" has a significant impact on cognitive development in children and this effect is continuous. Within the scope of this course, some verbal, numerical, and visual memory activities are aimed at increasing thinking skills in individuals, encouraging them to think computationally, improving reasoning ability, teaching probability thinking, developing effective decision-making skills, realizing problem situations, using appropriate solutions in problem situations, using trial and error, induction and deduction, probabilistic approach, and developing skills such as dividing the problem into its components (TTKB, 2013, pp.7-8). The basis of the mind games course is to develop cognitive, affective, problem-solving, self-regulating psychomotor skills in students (Ulusoy, Saygı, & Umay, 2017). With the mind games course, it is aimed that students can recognize and improve their intelligence level, develop creative and marginal solutions in problem situations, make fast and correct decisions, methodically develop a way of thinking, develop the ability to work both alone and in groups and in competitive situations, and develop positive emotions and thoughts in problem, obstacle, and problem situations within the framework of this game (MEB, 2013). Effective teaching of mind games; it will make a significant contribution to the skills such as reasoning, reasoning, critical thinking, problem-solving, attention in individuals, and the development of characteristics such as positive cooperation, group cooperation, tolerance, and patience (Adalar, & Yüksel, 2017). Based on this; Based on the assumption that brain games activities can have a positive effect on problem-solving skills and computer thinking skills, an experimental process has been carried out within the scope of this research.

The purpose of research

The aim of this research was to investigate the effect of mind games activities on problem-solving skills and computer thinking skills of fifth graders. For this purpose, the following questions have been tried to be answered:

• Do the mind - game activities impact the problem-solving skills of fifth graders?

• Do the mind games activities have an impact in the computational thinking skills of fifth graders?

• What are the students' views on mind -game activities?

Method

Research design

In this research, the sequential explanatory pattern from mixed research methods was used to obtain strong results. In the explanatory sequential pattern, qualitative and quantitative data were performed sequentially in two stages. The researchers first collected quantitative data and then collected qualitative data to strengthen these data. The quantitative part of the research was carried out using a semi-experimental design of pre-test-post-test without a control group. The independent variable of the research is Brain Games activities, and the dependent variables are computer thinking ability and problem-solving ability. In the qualitative part, content analysis was performed.

Study group

In this study, a convenient sampling method, which is one of the non-random sampling methods, was used. When it is evaluated in terms of time, money, and labor, the sample is chosen from easily accessible and applicable units due to existing limitations (Buyukozturk, 2012). The study group of the research consists of 17 fifth -grade students, 10 girls and 7 boys, studying at a secondary school in the 2021-2022 academic year in Adıyaman.

Experimental process

The experimental process was carried out for two hours a week for a total of six weeks within the scope of the elective mind games course. The following activities were carried out within the scope of the course:

Week 1: Kapsül game activities were performed out in the first week of the experimental process. In the first hour of the lesson, after the general rules of the game were explained, a few simple examples were applied. In the second hour of the lesson, the game was played. The general aim of the game is to write the numbers that correspond to all capsules by using the numbers given in the upper left corner of the box only once, as seen in Figure 1, based on the clues on the row and column edges of the box. In this game, only collecting is performed. Whatever the number of values given to the capsule game, only these numbers are used. A number is written on each capsule. The shaded areas outside the capsule game are hint areas. The sum of the numbers corresponding to that row or column must be equal to the hint numbers. In the game, clues with few capsules must be placed firstly. However, note that common capsules are used. Values of common capsules at the end of rows and columns need to be considered. Care should be taken to ensure that each number is used only once. Probabilistic approaches are important in such games.

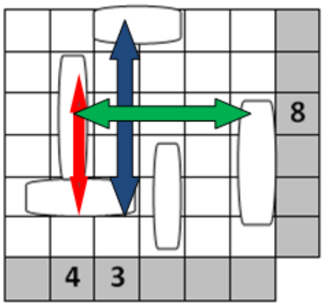

Figure 1 Kapsül Game

Week 2: In the second week of the experimental application, ABC connecting game activities was applied. In the first hour of the lesson, after the simple 2-to-3 binding methods were applied, in the second hour of the lesson, 4-to-5 binding methods were applied. ABC Context is a mind game prepared on a square ground consisting of letters and dots at equal distances. The general aim of the game is to connect the same letters with a line. That is, to connect the same letters with a line. The basic rule of the game is that one line does not intersect with another line, and no diagonal lines are used. Horizontal or vertical lines should be used when connecting letters to each other with lines. Lines should not be skipped over the letters, and the line should not be extended. After all the lines were drawn, no empty squares should remain. When Figure 2 is examined: It is seen that the same letters with red arrows are combined with vertical or horizontal lines.

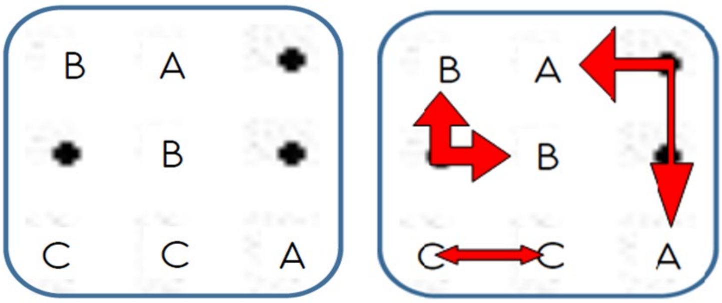

Figure 2 ABC Connecting Game

Week 3: Sudoku game activities were performed out in the third week of the experimental process. After explaining the rules of the game with 3*3 and 6*6 playgrounds in the first hour of the lesson, the game was played in the second lesson hour. Numbers from 1 to 6 must be used in the Sudoku game. The playing field consisted of six rows and six columns. There are 6 regions in a 6X6 Sudoku puzzle. In a Sudoku game, each row and column must contain all numbers and be used only once. An example Sudoku playground is given in Figure 3.

	6	4	3	2	
5	3			6	4
4					1
3					2
6	4			1	3
	1	3	4	5	

Figure 3 6x6 Sudoku Game

Week 4: In the fourth week of the experimental process, the Three Stones Game activities were performed out. In the first lesson hour, after the groups of two were selected, the rules and features of the 3 stone game were explained. In the second lesson hour, the groups separated in sets played the game against each other. This game is played by two people coming together. Players will be given A4 paper with a table with 2 columns and 2 rows drawn on it. The first player to start the game is determined by tossing a coin with a coin. Here, the player who starts the game puts a piece given to him where he wants. The opposing player then places a stone. In this way, both players place all their three pieces in order. A move is made after both players have placed their pieces. The player whose turn it is to play moves a piece to the nearest empty area by moving it once toward the line. The player who aligns all three of his pieces vertically, horizontally, or diagonally wins the game. A three -stone game won is exemplified in Figure 4.

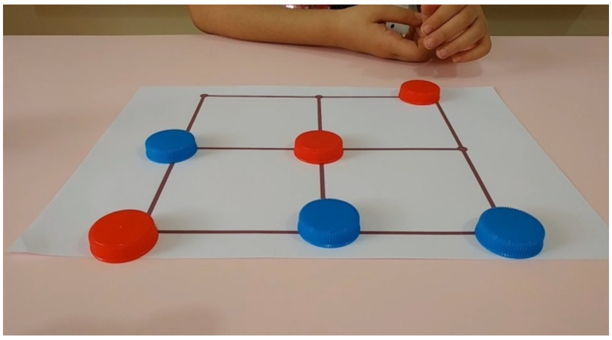

Figure 4 Tree Stone Game

Week 5: Kendoku game activity was performed out in the fifth week of the experimental process. The rules of the game were explained in the first lesson hour. In the second lesson hour, the game was played. The kendoku game is played with four basic mathematical operations: addition, subtraction, multiplication, and division. In Kendoku, numbers from 1 to n must be written only once in all rows and columns. Example: In a 3×3 Kendoku game, only numbers 1 to 3 are used. The numbers in the region with bold lines in bold should be equal to the number in the corner when calculated according to the operation of the region. The same numbers can be reused in the same region. There is only one solution in a Kendoku game. For example, in Figure 4, in the 3x3 Kendoku game, operations should be performed using the numbers 1, 2, 3 according to the number and sign in the areas given on the playing field. According to the 5+ clue in the upper left corner, it should place the numbers whose sum is 5. The number 3 with one box in the lower right corner should be written as it is. The remaining regions from the given clues must be completed according to their sign.

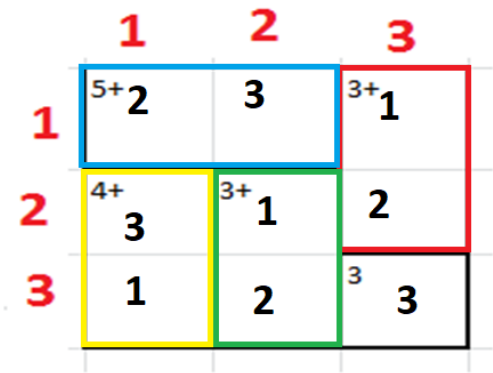

Figure 4 Resolved Kendoku Game

Week 6: In the fifth week of the experimental process, the Kakuro game activity was performed out. The rules of the game were explained in the first lesson hour. In the second lesson hour, the game was played. As a rule, Kakuro is played similarly to the Sudoku game, provided that the numbers from 1 to 9 are used once in each row and column. The numbers should be placed in such a way that they coincide with the sum of the numbers given in the corners. A number should only be used once in each row and column. In the given Kakuro game, numbers from 1 to 9 are placed. These placed numbers must be equal to the sum of the numbers in the corners of the squares in the row or column. However, the numbers in the corners of the boxes give the sum of the numbers to be written in that area. When Figure 5 is examined, it is immediately seen that the numbers 1 and 2 will be written in the green box, the numbers in the blue box will be 3 and 1, and since 8+8 will not come in the yellow box, the numbers 9 and 7 will be written.

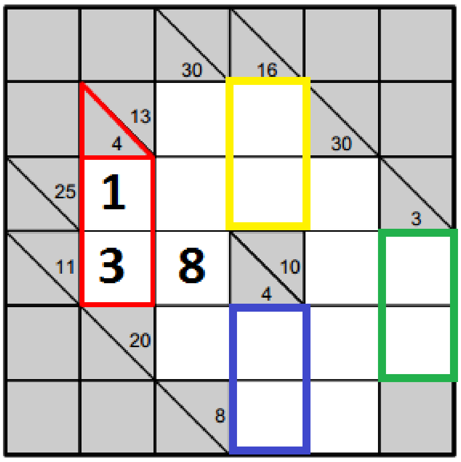

Figure 4 Resolved Kakuro Game

Moreover, these instructors were selected based on the following criteria: a) they have the relevant experiences teaching English subjects during the pre-pandemic period; they have relevant teaching experiences teaching English subjects during the pandemic period; c) they teach in a tertiary school situated in a rural area; and d) they teach students who live in rural areas where easy and strong access to the internet is unstable. With these criteria, the direction of the study is narrowed down according to the general purpose of the study.

Data collection tools

Problem-solving skill scale

To determine the problem-solving skill levels of students within the scope of the research, The 6-8.th grades Problem-solving Skills Scale" was used developed by Özpınar (2012). This scale consists of 18 items and a total of 3 factors, namely Understanding (4 items), Adaptation (6 items), and Evaluation (8 items). The Cronbach Alpha reliability value of the scale was 0.875. The Guttman Split Half internal consistency value, calculated using the test decoupling technique for the consistency between the two halves of the scales, is 0.797. The scale is of 4-point likert type. For this reason, the lowest score that can be taken from the scale is 18, and the highest score is 72. The high scores obtained on this scale without negative items mean that the student's problem-solving ability is high.

Computational thinking skill scale

Within the scope of the research, the Computational Thinking Skill Levels Scale adapted to the secondary school level by Korkmaz, Çakır, and Özden (2015) was used to determine the students' computer thinking skill levels. The scale consists of 22 items in 5 factors of 5-point likert type. the Cronbach alpha reliability coefficient was calculated as 0.809 for a total of 22 items. The names of the factors included in the scale, the number of items, and Cronbach Alpha reliability coefficients are summarized in Table 1.

Table 1 Computational Thinking Skill Scale's factors

Factors	Item Counts	Cronbach Alfa
Creativity	4	0,640
Algorithmic thinking	4	0,762
Collaboration	4	0,811
Critical Thinking	4	0,714
Problem-solving	6	0,867

Interview form

At the end of the experimental process, a semi-structured interview form was developed to determine the opinions of the students about the mind -game activities. The open-ended questions prepared were examined by two experts who had a doctorate in the field of educational technology. The necessary corrections have been made in accordance with the opinions of experts, and the final form of the interview form has been given. In the interview form, questions such as the difficulties encountered by the students during the application, the main problems in the mind game activities, the difficulty levels of the games, the evaluation of the games throughout the process, the evaluation of the activities among themselves, the evaluation of the activities in terms of time were included. The questions in the form are:

- Do you like mind games lessons? Do you find this lesson fun?
- Do you like Sudoku, Kendoku, Kakuro, 3 Stones, ABC Connecting, and Capsule game activities? Was it fun doing these activities?
- What was the game or subject that you had difficulty in mind games activities?
- Which skills do you think mind games activities contribute to?

Analysis of data

To determine whether parametric statistics can be used on the quantitative data collected within the scope of the research, it was first investigated whether the collected data were normally distributed, and the results are summarized in Table 2.

Table 2 Normality of data

Tests	X	SS	Skewness	Kurtosis	Shapiro-Wilk	p
Problem-solving Skill Pre-Test	75,81	10,28	,643	-,512	,933	,244

Computational Thinking Skill Pre-Test	71,27	8,14	,354	-,327	,965	,721
Problem-solving Skill Post-Test	80,30	11,59	-147	-,403	,971	,835
Computational Thinking Skill Post-Test	74,11	10,36	,083	-,242	,978	,940

In Table 2, when the test results applied as pre-test and post-test were examined, it was seen that there was no significant difference since $p>0.05$ according to Shapiro-Wilk result; in other words, the collected data were not normally distributed. However, since the skewness and kurtosis coefficients were between -1.5 and +1.5, it was accepted that the collected data showed a normal distribution (Tabachnick & Fidell, 2013). In this framework, it was assumed that the data collected within the scope of the research were normally distributed and it was decided to perform parametric analysis on the collected data, and the arithmetic mean, standard deviation, and repeated measurements were analyzed using the t test. In the analysis performed, $p<0.05$ value was accepted as the level of significance.

Results

The results of the post-test and pre-test on whether a difference in the problem-solving skills of the students during the experimental process are summarized in Table 3 with the sub-factors.

Table 3 The effect of mind games activities on problem-solving skills

Tests	N	X	sd	df	t	p
Problem-solving Pre-Test	17	75,81	10,28	16	-1,760	,097
Problem-solving Post-Test	17	80,30	11,59			
Comprehension Pre-Test	17	3,17	,51360	16	-1,588	,132
Comprehension Post-Test	17	3,30	,63449			
Application Pre-Test	17	3,13	,47054	16	-1,157	,264
Application Post-Test	17	3,30	,58806			
Evaluation Pre-Test	17	3,00	,46838	16	-1,068	,301
Evaluation Post-Test	17	3,13	,46708			

When the total problem-solving scores in Table 3 are examined, it is observed that the pre-test average is 75.8 and the post-test average is 80.3. However, it was determined that this differentiation was not significant ($t_{(2-16)}=-1.760$, $p>0.05$). When examined in terms of factors, post-test averages were higher than pre-test in all factors, but these differences were not significant (Comprehension: ($t_{(2-16)}=-1.588$, $p>0.05$); Application: ($t_{(2-16)}= -1.157$, $p>0.05$), Evaluation: ($t_{(2-16)}=-1.068$, $p>0.05$)) was determined. Accordingly, it can be said that the activities of intelligence games provide some contribution to the problem-solving skills of the students, but this contribution is not at a significant level. The results of the post-test and pre-test on whether a difference in the computational thinking skills of the students during the experimental process are summarized in Table 4 with the sub-factors.

Table 4 The effect of mind games activities on computational thinking skills

	N	X	sd	df	t	p
Computational Thinking Skill Pre-Test	17	71,27	8,14	16	-1,287	,216
Computational Thinking Skill Post-Test	17	74,11	10,36			
Creativity Pre-test	17	4,05	,76306	16	-,602	,555
Creativity Post-test	17	4,19	,69894			
Algorithmic Thinking Pre-test	17	3,05	,62205	16	-4,642	,000
Algorithmic Thinking Post-test	17	3,89	,64987			
Collaboration Pre-test	17	3,76	,65830	16	,049	,961
Collaboration Post-test	17	3,75	,97227			
Critical Thinking Pre-test	17	3,82	,78941	16	-1,725	,104

Critical Thinking Post-test	17	4,11	,82971			
Problem-solving Pre-Test	17	2,87	,83689	16	-,095	,926
Problem-solving Post-Test	17	2,89	,85785			

When the total scores of computational thinking skills are examined in Table 4, it is seen that the pre-test average is 71.27, while the post-test average is 74.11. However, it was determined that this differentiation was not significant ($t_{(2-16)}$=-1.287, p>0.05). When examined in terms of factors, it was found that the post-test averages were higher than the pre-test in factors, excluding Collaboration. This differentiation is significant in terms of algorithmic thinking skills: ($t_{(2-16)}$=-4.642, p<0.05). In terms of other factors, the differences were not significant (Creativity: ($t_{(2-16)}$=-.602, p>0.05); Collaboration: ($t_{(2-16)}$=.049, p>0.05); Critical Thinking: ($t_{(2-16)}$=-1.725, p>0.05); Problem-solving: ($t_{(2-16)}$=-.095, p>0.05)). Accordingly, it can be said that mind games activities contribute significantly more to students' computational thinking skills in terms of algorithmic thinking skills, but do not contribute significantly to other factors.

To obtain strong results from the research, semi-structured interviews were conducted with the students for the experimental process. The answers given by the 17 students who participated in the interviews regarding the questions asked about mind games activities, in general, are summarized below. The findings of the student's feelings and thoughts toward the mind games lesson are given in Table 5.

Table 5 Students' thoughts on the mind games lesson

Do you like mind -game lessons? Do you find this lesson fun?	f
I love this lesson because we are playing games.	16
I find these activities fun.	11
It was very nice because it developed our intelligence	4
Its fun because we learn new games.	3
Mind games are a good lessons.	2
I find it a little boring.	1

Do you like the Mind Games lesson to the students in the interview form made with the experimental group students for intelligence games? Do you find this lesson enjoyable? When the answers given to this question were examined, it was determined that 16 students liked the mind games lesson, 11 students found it fun, and four students found the lesson good. Only one student stated that he found it boring. When Table 5 is examined: It is seen that the experimental group students think that the mind games activities like the lesson because they played games during this study, they found this lesson fun, and they thought that they developed their intelligence with the lesson being nice. Accordingly, it can be said that the activities of mind games have a positive effect on making the lesson more enjoyable. The findings of the student's feelings and thoughts about the activities carried out during the experimental process are given in Table 6.

Table 6 Students' emotions and thoughts regarding the activities performed in the experimental process

Do you like Sudoku, Kendoku, Kakuro, Three Stones, ABC Connecting, and Capsule game activities? Was it fun doing these activities?	f
I find these activities fun.	13
I love this lesson because we are playing games.	5
It was all very easy and exquisite.	3
It was very nice because it developed my intelligence.	2
The Kendoku game was a bit difficult.	2
I struggled with some games.	2
I liked it because there were mathematical operations.	1
It’s fun because we learn new games.	1

Mind games are good lessons.	1
This improves our math skills.	1

In Table 6, when the students' thoughts on the mind game activities carried out in the experimental process were examined, 13 of the students found these activities fun, five of them liked the lesson because they played games, one of them found it fun because they learned new games, three of them found the games easy and beautiful, and two of them because they developed their intelligence. Some students stated that they found it beautiful and had difficulties in some games, while one student stated that they liked it because it was mathematical operations, that he found it fun because he learned new games, and that he had improved his math skills. In summary, it is seen that the students find the activities fun, they like the course with game activities, some games are difficult, and some games are easy. Accordingly, it can be said that the activities of intelligence games make the students happy, and the difficulty level of the games varies according to the student. The findings of the students' opinions about the difficulty level of the mind game activities are given in Table 7.

Table 7 Students' opinions on mind games activities

What was the game or subject that you had difficulty in mind games activities?	f
I struggled with some games.	7
The Kendoku game was a bit difficult.	6
It was all very easy and exquisite.	3
I find these activities fun.	1

When the students' thoughts on the difficulty of the mind games activities in Table 7 are examined, it is seen that six students find the Kendoku game difficult, seven students find it difficult in some games, while three students find the activities easy. Accordingly, it can be said that the students find some games difficult and some games easy, and the Kendoku game is more difficult for students than other games. The views on the contribution of the mind -game activities to the students are summarized in Table 8.

Table 8 Student opinions on the contribution of mind games activities

Which skills do you think mind games activities contribute to?	f
This improves our math skills.	11
It helps us develop our thinking.	5
I liked it because there were mathematical operations.	3
It develops our intelligence.	3
I find these activities fun.	1
It's fun because they are new games.	1

When the opinions of the students on the contribution of mind games are examined in Table 8, it is seen that five students stated that they developed their thinking skills, 11 students developed their mathematical skills, and two students stated that they developed intelligence. Accordingly, it can be said that students think that intelligence game activities contribute to their mathematical skills, thinking skills, and intellectual development.

Discussions and conclusions

It was observed that the mind games activities in the research contributed to the problem-solving skills, although not at a significant level, to some extent. In parallel, it has been observed in the literature that there is an increase in the problem-solving and reasoning skills of secondary school students who take elective intelligence games activities (Kurbal, 2015). Mandziuk (2007) emphasizes that mind games activities lead students to think and activate cognitive skills such as intuitive behavior, knowledge discovery, and creativity. In a study by Rincon-Flores, Gallardo, and de la Fuente (2018), it was stated that gamification activities have positive contributions to mathematics lessons. In the MEB (2013) Secondary School Mind Games Curriculum, it is emphasized that students should activate their mathematical thinking skills, develop their reasoning and logical thinking skills, and experience mental processes. The mind games lesson is not a lesson where students take notes, memorize, and listen to the lesson; in contrast, it is a course in which he directly participates in activities by doing and living, and puts his mental processes into action by thinking and practicing. In the literature, it is stated that there is a strong positive correlation between school performance and mind games, that mind games are important for activating students' thinking skills and developing their reasoning skills, as well as contributing positively to mathematics and reasoning skills (Bottino, Ott, & Tavella, 2013).

It was determined that the mind games activities carried out within the scope of the research contributed significantly to the computational thinking skills of the students, especially in terms of the algorithmic thinking factor. Considering that the process of playing mind games is a problem-solving process in general, it can be said that algorithmic thinking skills require training in this process. As a matter of fact, according to Wing (2008), Computational thinking, which is a kind of analytical thinking; It uses common ways with mathematical thinking in problem-solving, engineering when designing and evaluating a complex system, and scientific thinking in understanding concepts such as computability, intelligence, intellect, and human behavior. Similarly, Curzon (2015) defines computational thinking as a basic skill that means problem-solving for people and emphasizes the necessity of understanding what the problem is before thinking about solutions while solving a problem from a certain perspective. According to ISTE (2015), computational thinking; includes creativity, algorithmic thinking, critical thinking, problem-solving, communication, and collaboration skills (ISTE).

At the end of the study, in the interview form made with the students, they said that they liked this lesson very much and that they liked the activities. It is possible to find parallel results in the literature. It was observed that the students generally enjoyed this course (Alkaş Ulusoy, Saygı, & Umay, 2017; Devecioğlu & Karadağ, 2014). Additionally, it can be said that mind games contribute to the motivation of students and the strengthening of social relations between students. For example, in a study by Sailer (2021), it was observed that classroom gamification had a positive effect on students' social skills, while keeping students' motivation high in classroom learning activities. De Castell and Jenson (2007) emphasized that games are important in students' learning environments. He stated that the games helped students freely design their own learning environments, while encouraging them to "learn intelligently and willingly". According to Squire and Jenkins (2003), a game that is well designed in terms of its features motivates the learner while also directing learning. The games developed according to De Gloria, Bellotti, and Berta (2014): artificial intelligence, advanced technology, engineering, machine learning, etc. It has been stated that they will have positive contributions to areas such as It has been stated that students who have difficulties in learning environments can reach their learning goals more easily. Students stated that they found the lesson fun, some games were easy for them, and the Kendoku game was more difficult than other games. Students evaluate their activities as developing intelligence and enjoyable. In parallel with these findings, it is emphasized in the literature that mind games activities contribute positively to mental thinking skills and positively affect student achievement and being active in the lesson (Alkaş Ulusoy, Saygı, & Umay, 2017; Devecioğlu & Karadağ, 2014)

When all these results are evaluated, it is seen that there is a parallelism between the results obtained compared with the literature and results of the research. It was concluded that mind games activities contribute to students' problem-solving skills and computational thinking skills;

however, students enjoy mind games activities, and mind games activities make learning environments enjoyable and increase students' motivation. In this context, considering that intelligence games activities make learning environments more enjoyable and contribute to thinking skills, albeit limited, it can be suggested that these activities be included in the lessons.

Disclosure statement

No potential conflict of interest was reported by the author(s).

References

Oluk, A., Korkmaz, Ö., & Oluk, H. A. (2018). Effect of Scratch on 5th graders' algorithm development and computational thinking skills. *Turkish Journal of Computer and Mathematics Education, 9*(1), 54-71. https://doi.org/10.16949/turkbilmat.399588

Adalar, H., & Ysüksel, İ. (2017). Intelligence games curriculum from social studies, science and other branch teachers' point of view. *Electronic Turkish Studies, 12*(28), 1-24. http://dx.doi.org/10.7827/TurkishStudies.12428

Alkaş Ulusoy, Ç., Saygı, E., & Umay, A. (2017). Views of elementary mathematics teachers about mental games course. *Hacettepe University Journal of Education, 32*(2): 280-294. http://dx.doi.org/10.16986/HUJE.2016018494

Ananiadou, K., & Claro, M. (2009). 21st century skills and competences for new millennium learners in OECD countries. OECD education working papers, no. 41. *OECD Publishing* (NJ1).

Aslan, M. (2019). Examination of problems experienced by teachers teaching mind games courses. *Scientific Educational Studies, 3*(1), 56-73. https://doi.org/10.31798/ses.493223

Bottino, R. M., Ott, M., & Tavella, M. (2013). Investigating the relationship between school performance and the abilities to play mind games. In *European Conference on Games Based Learning* (p. 62). Academic Conferences International Limited.

Bulut, A. E., & Yılmaz, M. (2021). Determining the computational thinking skill levels of science high school students. *Gazi Journal of Educational Science, 7*(1), 80-91.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2012). *Scientific Research Methods*. Ankara: PegemA Pub.

Çınar, O., Hatunoğlu, A., & Hatunoğlu, Y. (2009). Teachers' problem-solving skills. *The Journal of Erzincan Educational Faculty, 11*(2), 215-226.

Curzon, P. (2015). *Computational Thinking: Searching to Speak.* Available at: http://teachinglondoncomputing.org/free-workshops/computational-thinking-searching-to-speak/

De Castell, S., & Jenson, J. (2007). Digital games for education: When meanings play. *History and Theory of the Arts, Literature and Technologies,* (9), 113-132.

De Gloria, A., Bellotti, F., & Berta, R. (2014). Serious games for education and training. *International Journal of Serious Games, 1*(1). https://doi.org/10.17083/ijsg.v1i1.11

Demir, Ö., & Seferoğlu, S. S. (2017). Yeni kavramlar, farklı kullanımlar: Bilgi-işlemsel düşünmeyle ilgili bir değerlendirme [New concepts, different uses: An evaluation of computational thinking]. H.F. Odabalı, B. Akkoyunlu ve A. İşman (Ed). *Eğitim teknolojileri okumaları [Educational technology readings],* (part 41, p. 801-830).

Demirtaş, H., & Dönmez, B. (2008). Secondary school teachers' perceptions about their problem-solving abilities. *Inonu University Journal of Education Faculty, 9*(16), 177 - 198,

Devecioğlu, Y., & Karadağ, Z. (2016). Evaluation of mind puzzle course at the context of goals, expectations, and recommendations. *Journal of Bayburt Education Faculty, 9*(1), 41- 61.

Dündar, S. (2009). Analyzing the relationship between problem-solving skills and personality characteristics of university students. *İzmir Journal of Economics, 24*(2), 139-150.

Gülbahar, Y., Kert, S. B, & Kalelioğlu, F. (2019). The Self-Efficacy Perception Scale for computational thinking skill: Validity and reliability study. *Turkish Journal of Computer and Mathematics Education, 10*(1): 1-29. https://doi.org/10.16949/turkbilmat.385097

Henderson, P. B., Cortina, T. J., & Wing, J. M. (2007, March). Computational thinking. In Proceedings of the 38th SIGCSE technical symposium on Computer science education (pp. 195-196).

Iste. (2015). *CT Leadership toolkit.* Available at http://www.iste.org/docs/ct-documents/ct-leadershipt-toolkit.pdf?sfvrsn=4

Kadır, P. (2011). Researching the relationship between the influence of games on elementary school students, their gender and lesson success variables and their game preferences. *Educational Research and Reviews, 6*(2), 208-214.

Karabulutlu, E. Y., Yılmaz, S., & Yurttaş, A. (2011). The relationship between emotional intelligence levels of students and problem-solving skills. *Journal of Psychiatric Nursing, 2*(2), 75-79.

Kirriemuir, J., & Mc Farlane, A. (2004). Literature review in games and learning. https://www.scirp.org/(S(351jmbntvnsjt1aadkposzje))/reference/ReferencesPapers.aspx?ReferenceID=2636552

Koray, Ö., & Azar, A. (2008). An analysis of high school students' problem-solving and logical thinking abilities in terms of gender and preferred field. *Kastamonu Education Journal, 16*(1), 125-136.

Korkmaz, Ö., Çakır, R., & Özden, M. Y. (2015). Computational thinking levels scale (CTLS) adaptation for secondary school level. *Gazi Journal of Education Science, 1*(2), 67-86.

Korkut, F. (2002). Problem-solving skills of high school students. *Hacettepe University Journal of Education Faculty, 23*(23), 177-184.

Kurbal, M. S. (2015). *An investigation of sixth grade students' problem-solving strategies and underlying reasoning in the context of a course on general puzzles and games* (Unpublished master's thesis). Metu, Ankara.

Kaya, M., Korkmaz, Ö., & Çakır, R. (2020). The effect of gamified robotics activities on the problem-solving and the computational thinking skills of the secondary school students. *Ege Journal of Education, 21*(1), 54-70. https://doi.org/10.12984/egeefd.588512

Mandzıuk, J. (2007). Computational intelligence in mind games. In: *Challenges for computational intelligence*. Springer, Berlin, Heidelberg, p. 407-442.

Özpınar, İ. (2012). *Study of developing scales to measure the skills in 6th - 8th grade mathematics curriculum* (Unpublished PhD dissertation). Karadeniz Technical University, Trabzon

Özsoy, G. (2005). The relationship between problem-solving skills and mathematical achievement. *Gazi University, Gazi Education Faculty Journal, 25*(3), 179-190.

Rahman, M. M. (2019). 21st century skill "problem-solving": Defining the concept. *Asian Journal of Interdisciplinary Research, 2*(1), 64-74. https://doi.org/10.34256/ajir1917

Rincon-Flores, E. G., Gallardo, K., & de la Fuente, J. M. (2018). Strengthening an educational innovation strategy: Processes to improve gamification in calculus course through performance assessment and meta-evaluation. *International Electronic Journal of Mathematics Education, 13*(1), 1-11.

Sailer, M., & Sailer, M. (2021). Gamification of in-classactivities in flipped classroom lectures. *British Journal of Educational Technology, 52*(1), 75-90.

Shute, V. J., Sun, C., & Asbell-Clarke, J. (2017). Demystifying computational thinking. *Educational Research Review,* 22, 142-158. https://doi.org/10.1016/j.edurev.2017.09.003

Sırakaya, D. A. (2019). The effect of programming teaching on computational thinking. *Turkish Journal of Social Research, 23*(2), 575-590.

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics (Sixth Edition)*. USA: Pearson Education Limited.

Squire, K., & Jenkins, H. (2003). Harnessing the power of games in education. *Insight, 3*(1), 5-33.

Şahin, Ç. (2004). Basic philosophy of problem-solving. *Atatürk University Journal of Kazım Karabekir Education Faculty,* 10, 160-171.

Temel, V., & Ayan, V. (2015). Investigation of physical education and sports teachers' problem-solving skills, decision making styles and organizational commitment levels. *Journal of National Sport Sciences, 6*(1), 11-29.

TTKB, (2013). Ortaokul ve İmam Hatip Ortaokulu Zekâ Oyunları Dersi Öğretim Programı [Secondary School and Imam Hatip Secondary School Intelligence Games Lesson Curriculum], http://mufredat.meb.gov.tr/Dosyalar/202152512057724-zeka_oyunlari.pdf

Tutulmaz, M. (2019). *Design, application and evaluation of data visualization towards development of computational thinking skills* (Unpublished master's thesis). Hacettepe University, Ankara.

Toptaş, V., & Kılıçkaya, M. (2017). Problem-solving: Searchiry literatur. *International Journal of Education Technology and Scientific Research, 2*(2), 20-31.

Türkoğlu, B., & Uslu, M. (2016). The effect of game based cognitive development programme on cognitive development of 60-72 months old children. *International Journal of Education Sciences, 3*(6), 50-68.

Uslu, N. A. (2018). The effect of visual programming activities on secondary school students' computational thinking skills. *Journal of Ege Education Technologies, 2*(1), 19-31.

Uluyol, Ç., & Eryılmaz, S. (2015). Evaluation of FATIH project in the consideration of 21st century skills. *Gazi Univertsity Gazi Education Faculty Journal, 35*(2), 209-229.

Ünsal, Y., & Ergin, İ. (2011). Problem-solving strategies using problem-solving process in science education and an example application. *The Journal of Defense Sciences, 10*(1), 72-91.

Üzümcü, Ö., & Erdal, B. A. Y. (2018). A new 21st century skill in education: Computational thinking. *International Journal of Social Sciences in Turkish Cultural Geography, 3*(2), 1-16.

WEF, (World Economic Forum), (2020), *The Future of Jobs Report*, October, https://www.weforum.org/reports/the-future-of-jobs-report-2020

Wing, J. M. (2006). Computational thinking. *Communications of the ACM, 49*(3), 33-35.

Wing, J. M. (2011). Research notebook: Computational thinking—What and why? The Link Magazine, Spring. Carnegie Mellon University, Pittsburgh. https://www.cs.cmu.edu/link/research-notebookcomputational-thinking-what-and-why

Wing, J. M. (2008). Computational thinking and thinking about computing. *Phil. Trans. R. Soc. A,* 366: 3717–3725. https://doi.org/10.1098/rsta.2008.0118

Yolcu, V. (2018). *The effect of using robotics on academic success, computational thinking skills and transfer of learning in programming education* (Unpublished master's thesis), Süleyman Demirel University, Isparta.

Yıldız M., Çiftçi E., & Karal H. (2017). Bilişimsel düşünme ve programlama [Computational thinking and programming]. H.F. Odabalı, B. Akkoyunlu ve A. İşman (Ed). *Eğitim teknolojileri okumaları [Educational technology readings]*, (p. 75-86).