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Investigation of the Effect of Memory Games on Reasoning Skills of Teacher Candidates*

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Abstract

Memory games are a type of intelligence game that require fast thinking and practical problem-solving skills and are generally referred to as games that aim to improve mental skills. Intelligence games are a whole group of games that appeal to the brain's fast thinking and decision-making characteristics. These games are found to be very useful for increasing visual and verbal development. In addition to visual or verbal memory, memory games are called games that use neurological memory, cognitive, problem-solving, and predicting abilities in an individual, mutual, or team game. Memory games are of great importance in math education. The benefits of memory games for problem-solving skills cannot be denied. According to Umay and Kaf (2005), problem-solving and math cannot be considered separately. To thoroughly learn and succeed in math is through mathematical problem-solving and thinking. This article has been prepared to help primary school math teacher candidates gain proficiency in problem-solving skills while performing moves in the games, to be able to look at strategies from a multi-dimensional perspective and to be aware of problem-solving skills they can use to win. A total of 10 different questions were applied in the form of a pre-test and a post-test, and the students filled out the problem-solving scale. The aim was to monitor the development of mathematical thinking and problem-solving skills before and after the training. When the data obtained after the game process was examined, it was observed that memory games contributed positively to the mathematical problem-solving skills of teacher candidates during the training process.

Keywords: Math Education, Mathematical Problem-Solving, Memory Games, Predicting, Processing Ability

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INTRODUCTION

Intelligence is the mental ability required for understanding the environment, making choices, and shaping and adapting to the environment (Sternberg, 1997). Today, intelligence researchers agree that intelligence can be developed through interactions with the environment or through experiences rather than being solely a neurological and innate concept (Deary et al., 2007). In terms of intelligence, the ability to understand the relationship between abstract or concrete objects using concepts and perceptions, abstract thinking, problem-solving, and using them towards a goal is referred to as intelligence (MoNE, 2013).

Memory games are a type of game that can be visual or verbal, short or long-term. As a type of intelligence game, memory games help students develop their ability to understand and evaluate problems, look at things from different perspectives, make practical and correct decisions in a problem situation, and develop the habit of focusing on solutions. It also helps students effectively use problem-solving skills (MoNE, 2013).

When looking at the teaching content given to students, it is important that this content also contributes to the development of skills such as abstract thinking, problem-solving, and understanding the relationship between abstract and concrete objects, which are also included in the definition of intelligence (Saygı & Alkaş-Ulusoy, 2019). It is helpful to examine the contributions of play to teaching and students to collect content that can develop these skills together (Kirriemur & McFarlane, 2004).

In the development of strategic thinking, planning, communication, numerical operations, discussion, group decision-making, and data processing skills, Bottino and Ott (2007) emphasize that board games are critical in the development of thinking skills, logical reasoning, and strategic thinking. In addition to the educational benefits of the game, it can also increase motivation (Rosas et al., 2003), increase attention and focus (Garris et al., 2002), and develop a positive approach to learning (Lou et al., 2001). These results of the game concept correspond to the possibility of developing intelligence in individuals. The game, defined as an activity that includes a series of activities involving one or more people, offers the opportunity to simultaneously develop many skills included in the definition of intelligence (Dempsey et al., 2002). Each game has goals, limitations, rules, scoring, and results. Memory games, in particular, enable individuals to recognize their potential, make quick and correct decisions, find solutions to problems, and, most importantly, continuously improve themselves (Devecioğlu & Karadağ, 2014).

People of all ages for entertainment can play memory games. Still, they are also known to be used to keep the memory skills of people over a certain age sharp or to help individuals who have lost or are losing their mental health regain their mental health (Evans & Wilson, 1992). It has been found

that memory games are also frequently used in educational and instructional activities, rather than in health or daily life use (Saygı & Alkaş- Ulusoy, 2019).

The current study aims to determine the effect of game-based mathematics education on the cognitive processes of primary school mathematics teacher candidates. When the literature is reviewed, it is found that there are different studies on game-based mathematics education (Callaghan, 2017; Çankaya & Karamete, 2008; Dele-Ajayi et al., 2019; Divjak & Tomić, 2011; Gyöngyösı-Wiersum, 2012; Hays, 2005; Hussein et al., 2022; Karamustafaoğlu & Kaya, 2013; Kebritchi, 2007; Kebritchi et al., 2010; Özdemir, 2011; Özüsağlam, 2007; Randel et al., 2016; Uğurel, 2008). Generally, it is seen that computer-based or classic games are included in mathematics education studies. In addition, the studies have focused on the development of games for the teaching of a subject. This study aims to develop the cognitive process skills of primary school mathematics teacher candidates.

The games used in the study were designed and adapted for this research. The PowerPoint interface was used in the Find Your Partner memory game, and the Scratch application was used in the Who Knows the Numbers Wins game. The use of these games and the skills measured in the study increase the importance of the research on mathematics education with games. The rapid development of technology has made it inevitable to use these new technologies in solving educational problems (Çankaya & Karamete, 2013). For these reasons, the main aim of the study was to examine the contribution of game-based mathematics education to the development of mathematical cognitive process skills. The objectives of the students in this direction are:

• To help students learn the basic rules of the "Guess What?", "Who Knows the Numbers Wins?", and "Find Your Partner" games,

• To help students become aware of the cognitive processes they need to use to win in the "Guess What?", "Who Knows the Numbers Wins?", and "Find Your Partner" games,

• To help students transfer their problem-solving and cognitive process strategies while playing the game to solving mathematical problems.

The Problem of the Research

This study it is aimed to determine the effect of “Guess What?”, “Find Your Partner” and “Who Knows the Numbers Wins” are memory games prepared by teacher candidates on logical thinking skills. In this direction, the problem of the research and the sub-problem questions are given below:

The research problem is, what is the effect of game-based mathematics teaching on primary mathematics teacher candidates' logical thinking and problem-solving skills?

Two sub-problems are answered in order to provide an answer to this problem.

1. What is the effect of game-based mathematics teaching on the logical thinking skills of primary mathematics teacher candidates?

2. What is the effect of game-based mathematics teaching on the problem-solving skills of primary mathematics teacher candidates?

METHODOLOGY

In this study, the experimental design and single group pretest-posttest model from quantitative research designs have been used to investigate the effect of mathematics education-specific games on logical thinking skills. The path followed in the study is given in Figure 1.

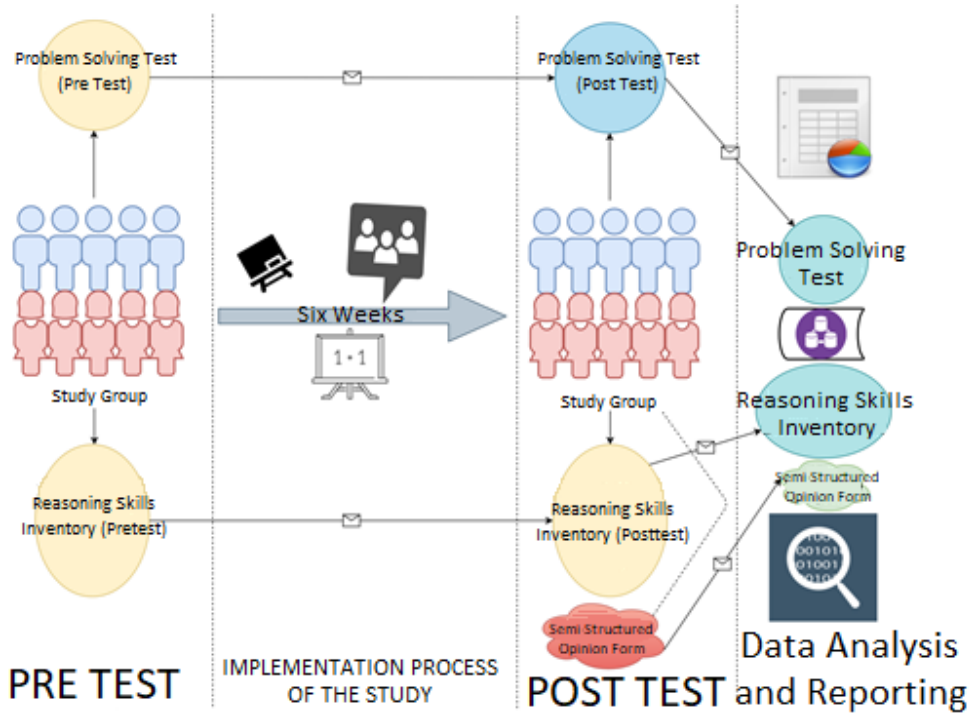

Figure 1 The Path Followed in the Study

Study Group

The research study group was selected with a convenience sampling method. The focus of the research is the relationship between math games and problem-solving. This study was carried out with ten teacher candidates attending the primary school mathematics teaching program at a public university in a province located in the southern part of Turkey. The voluntary participation of the candidates in the study was taken into account.

Data Collection Tools

Two data collection tools were used to collect the data for the research. The first was problem-solving activities, and the second was an inventory of problem-solving skills.

Reasoning Skills Inventory: The reasoning skills inventory was developed by Duran (2014) (see Appendix 2). The data obtained from the Inventory of Problem-Solving Skills can be analyzed in two ways. First, it can be considered as a whole scale and analyzed based on the total score, and second, it can be used in the analysis as an inventory in each sub-dimension considered a different scale. When preparing the inventory, it was considered more appropriate to use percentage expressions such as %20, %40, %60, %80, and %100 instead of the options "I completely disagree," "I disagree," "I partly agree," "I agree," "I completely agree," because adjectives such as "always," "usually," "often," "sometimes," "seldom," "never" are not widely used in the Turkish language. Therefore, using percentage intervals in ratings would give more objective results. In this study, a comparison was made based on the total score. The Cronbach alpha reliability coefficient of the scale is .89.

Problem-Solving Activities: The second data collection tool used in the research was open-ended questions developed by Yesildere and Türnüklü (2007) to examine "Mathematical Thinking and Problem-Solving Processes" (see Appendix 1). A total of 10 questions were used to track the development of mathematical thinking and problem-solving skills before and after the training.

The researchers scored both problem-solving activities using the form provided in Table 1, which was used by Yesildere and Türnüklü (2007). The reliability coefficient Kendall W coefficient was used to analyze the inter-rater reliability for the evaluation. The rubric used is provided in Table 1.

Table 1 Rubric to be Used for Evaluating Open-Ended Problems

Score	Description
Four points	The solution method and explanation are correct, expressing thoughts with proper mathematical notation and symbols, clearly expressing reasoning, and being fully understood.
Three points	The solution method and explanation are mostly correct, with a few minor errors or uncertainties, expressing thoughts with proper mathematical notation and symbols, expressing reasoning, and being fully understood.
Two points	The solution method and explanation show some understanding of the problem, but the explanation indicates a need for more information in certain aspects.
One point	The solution method and explanation show limited knowledge of the subject.
Zero points	The answers are given to solutions that solve the problem incorrectly or leave it unanswered.

The implementation process of the study was carried out in July and August 2021. The researchers prepared all the activities used. Based on the reasoning skill, the activities were structured to cover six weeks. Therefore, data were collected through pre-tests before the implementation stage, and the primary implementation continued for six weeks, after which the study was completed by conducting a final test. For this purpose, the researchers gained experience in the "Mathematics Teaching with Games" class and developed content for the "Guess What?" (Video 1), "Who Knows the Numbers Wins" (Video 2), and "Finding the Pair" (Video 3) games (Appendix 3).

Information about the games used in the study is shown in Table 2.

Table 2 Information on Memory Games Used in the Practice

Game name	Description of the game
Guess What?	It is a game where the teacher candidate tries to find the geometric shape held by the candidate opposite by asking distinguishing questions. Within the scope of this game, candidates can ask about the characteristics of geometric shapes, their areas of use in daily life, etc. The candidates are expected to guess the shape with the least number of questions correctly.
Finding the Pair	The teacher candidates must choose the card with the question and then answer. If they give the correct answer, they are expected to match it with one of the other cards by selecting it. The one who knows the question will get 3 points, and the one who knows the question and makes the correct match will get 7 points.
Who Knows the Numbers Wins	In the second stage of the game, the "bonus question" section, there are no common questions. It is based on the teacher candidates answering the questions about the numbers appearing to them within a specific period. Each candidate is expected to answer their unique questions within the specified time.

Table 2 lists the games used and how they are played. Before the implementation stage of the games, the instructions on how to play them have been explained, and pre-trial practice sessions have been conducted for each game.

The "Guess What?" game material was prepared to measure the dimension of understanding geometric shapes through the prediction of mathematical reasoning skills. The main feature of the material is to develop the logical reasoning power of the individual. In addition, this game analyzes geometric objects skillfully and provides fast perception while imagining geometric shapes in the head and understanding their relevant properties. The game to be designed is for two players and is played reciprocally. First, the players take their positions opposite each other and take the "Guess What?" boards in their hands. Then, they carefully examine the pictures inside by opening all the windows on the boards. One of the players selects a geometric shape and tries to guess it from the other player. After the first player has selected a geometric shape, the other player closes all the windows on the board and asks questions. For example, Is it three-dimensional? How many vertices does it have? Does it have corners? ... The player who tries to guess the geometric shape by asking specific questions focuses on finding the geometric shapes that match the question on the board after opening two windows with each question. This game also requires a good memory because reopening windows that do not match the desired properties will take time for the player and prolong the game.

The second memory game designed is called " Who Knows the Numbers Wins" and adapted from the city animal object game to mathematics. This memory game is planned to contribute to the development of reasoning skills by allowing us to recall and use previously learned information when faced with a correct problem. This game was developed with the Scratch application and was also played through this application. It is planned to be a fun and instructional game that will attract the attention and focus of students with its exciting and beautiful questions.

The paper game prepared for the game is distributed to the players, and one of the players quietly starts counting from 1 to 15. The other player gives him the command, "Stop." When he stops,

the table is filled according to the number he was at in the game. The one who fills in the first and correct set wins and gets +1. Bonus questions are created at the end of each set. These questions should be related to the learning area of Numbers and Operations. The rivals choose and create questions from options such as multipliers and factors, exponential numbers, and root numbers, and the one who knows and answers the bonus section correctly first gets +2. The players play as many rounds as they want, and at the end, the pluses are added up, and the winner of the game is determined.

The memory game "Find the Pair" has been designed in conjunction with mathematics. The game was developed with the PowerPoint interface and was also played through this interface. The aim is to develop both visual and mathematical reasoning skills. The game includes questions from everyday life and visual and operational questions. In this way, it aims to contribute to both figurative and logical reasoning. Similarly, the aim is to develop problem-solving skills while thinking about operational questions.

The materials necessary to prepare the game in the form of concrete material are of a type that many people can access. These are; cardboard, scissors, adhesive, colored papers, colored pens, and stickers. The cardboard and colored papers are cut into rectangles for the game. Questions were prepared and written on the cards based on the gains determined from the primary mathematics teaching programs. Two players were determined for the game and asked to answer the question within a certain period, and matching was made accordingly. During the implementation stage of the study, an online meeting program was used.

Data Analysis

The Wilcoxon Signed Ranks test, a non-parametric analysis method, was used to analyze the data in the sub-problems of the study since the number of study participants is below 30. In addition, before moving on to the analysis stage of the second problem, the Kendall W reliability coefficient was calculated among the raters (Mertler & Vannatta, 2005; Tabachnick & Fidell, 2014; Thode, 2002).

Findings and Interpretation

In this section, the results of the analysis of the sub-problems prepared to answer the research problem are given, and the interpretation of these results is provided. Problem: What is the effect of game-based math education on the problem-solving and critical thinking skills of primary school math teacher candidates?

To answer this problem, the following sub-problems have been addressed.

First Sub-Problem: What is the effect of game-based math education on the critical thinking skills of primary school math teacher candidates?

To answer the first sub-problem, the Wilcoxon signed ranks test was applied to the data collected from 10 teacher candidates before and after the study. The obtained data are presented in Table 3.

Table 3 Results of the Wilcoxon Signed-Rank Test for Pre- and Post-Training Reasoning Skills Inventory Scores

Reasoning Skills Inventory Scores	N	Mean Rank	Sum of Rank	z	p	d
Negative Ranks	0	0	0	-2.810	0.005	0.79
Positive Ranks	10	5.50	55.00			
Ties	0					

Table 3 shows that the mean of positive ranks (5.50) is higher than the mean of negative ranks (0). This finding indicates an increase in problem-solving ability scores after the experiment. The analysis results show that this difference between the measurements before and after the training is statistically significant ($z = -2,810$, $p < 0.05$). In other words, the experimental procedure carried out after the pre-training measurement was effective and increased the problem-solving ability scores of the students. The calculated effect size value also shows that the training had a high impact ($d = 0.79$).

Second Sub-Problem: What is the effect of game-based math teaching on the problem-solving skills of primary math teacher candidates?

Here, the problem users have been evaluated by two separate researchers using a rubric. To do this, the results of the Wilcoxon signed-rank test are given after the findings on the reliability of the problems used as pre-test and post-test scores.

Findings on Reliability of Scores

Table 4 shows Kendall's W coefficient, which demonstrates the agreement between the pre-test and post-test scores given by two scorers to 10 students in terms of problem-solving skills.

Table 4. Kendall's W Coefficient Calculated for Total Scores Among Raters

Concordance Coefficient	Pre-Test Total Score
Kendall's W	0,989*
Concordance Coefficient	Post-Test Total Score
Kendall's W	0,994*

*p<0,01

Upon examination of Table 4, the agreement coefficient between the two scorers based on the total scores obtained from the pre-test and post-test was calculated to be 0.989 for the pre-test and 0.994 for the post-test. These values were found to be significant. Kendall's agreement statistic, which considers the order of differences, was highly significant for both scorers. This finding can be interpreted as the scorers showing high similarity in scoring individuals.

Findings on Second Sub-Problem

The results of comparing the mean scores given by two scorers in terms of problem-solving skills using the Wilcoxon signed-rank test for pre-test and post-test scores are presented in Table 5.

Table 5 Results of the Wilcoxon Signed Rank Test for Pre- and Post-Training Problem-Solving Skills Scores

Problem-Solving Skills Scores	N	Mean Rank	Sum of Rank	z	p	d
Negative Ranks	0	0	0	-2.807	0.005	0.788
Positive Ranks	10	5.50	55.00			
Ties	0					

Upon examination of Table 5, it can be seen that the mean of the positive ranks (5.50) is higher than the mean of the negative ranks (0). This finding indicates an increase in problem-solving skill scores after the experiment. The analysis results show that the difference that emerged before and after the education is statistically significant ($z = -2.807$, $p < 0.05$). In other words, the experimental procedure carried out after the measurement before education was effective and increased the problem-solving skill scores of the students. The calculated effect size value also shows that education has a high impact ($d = 0.788$).

DISCUSSION AND CONCLUSION

Based on the pre-test results, it was observed that teacher candidates have limited and closed-thinking skills in open-ended questions and have difficulty expressing their answers. It was also observed that math teacher candidates quickly answered most of the questions in the first section of the "Who Knows the Numbers Wins" game, such as "Is it odd or even? Is it prime? What is the square of the number?", but had difficulty with some questions, such as finding the squares of specific numbers between 10 and 15, due to time constraints and making mistakes such as taking the square of the previous or next number.

In the second part of the game, 'Bonus Questions,' the participants gave incorrect answers to most of the bonus questions. When asked about their opinions on the game and their suggestions, they said that the time was sufficient in the first part of the game, 'Is it even or odd? Is it prime? What is the square of the number?', but they still wanted the time to be longer in the game overall, especially in the bonus question part, where they said the time was short. They mentioned that the difficulty level of the bonus questions was high, while the first part of the game was more accessible. When asked for positive criticism, they said that they found the game more interesting when it was played through the Scratch application and that they liked the design and aesthetic appearance of the game. They said that they found the game very entertaining, covered multiple gains, helped us remember and use our previous knowledge, and found it educational.

The candidates found it difficult to remember the shapes they opened in the “Guess What?” game, and as a result, they could not easily and quickly recognize the shape being asked. When asked about their thoughts on the game, the candidates said it was difficult for a primary school level. Still, it was a game that contributed to developing strategies for thinking and memory.

In the “Finding the Pair” game, it was observed that teacher candidates struggled to solve questions with geometric shapes but found it easier to solve and match questions that required calculation. Questions with geometric shapes facilitated matching. In the game, which contained questions from everyday life, the candidates could answer the questions promptly without any difficulty. The candidates held the cards to be matched in their memory; most of the candidates located them, a few grouped them in their minds according to colors, and a few held them randomly. When asked for their opinions at the end of the game, they said they liked it, found it entertaining and educational, and expressed that they could benefit from it in their future classrooms when they become teachers.

Materials presented visually facilitate more lasting learning and make lessons more enjoyable and productive for students (Türkmen & Soybaş, 2019). In addition to the views of teacher candidates on the contribution of the memory game played to the mathematical development of students, it is also pointed out in the literature that multiple mathematical ideas are used simultaneously in memory games that increase the durability of the game, and that many mathematical abilities can be increased and developed within a single game. This is because the games require active participation, and the materials used in the games activate the cognitive structures in the students' minds (Randel et al., 1992). The 'Find Your Pair,' 'Who Knows the Numbers Wins,' and 'Guess What?' games are based on memory activities, so they support the teaching of different strategies, create a class environment with high motivation and belief in learning while having fun, and contribute to the correct and meaningful learning of mathematical concepts, as well as improve time control, efficiency, brainstorming and quick thinking. In order to gain these achievements, these kinds of mind-strengthening activities can be carried out by playing games and providing opportunities for them to improve themselves in this direction. Based on these findings, it can be concluded that game-based teaching has a positive effect on candidates' mathematical thinking and critical thinking skills.

Recommendations

- Memory games should be considered as an important category among intelligence games. Research can be conducted on the contribution of these games to teaching and problem-solving skills.
- Memory game teaching can be expanded by opening memory game training courses within the school or privately.

- New games that integrate technology into mathematical problem-solving skills can be developed, and students can gain these skills.
- Both technological and educational lesson plans can be created by expanding computer-assisted memory games and including them in the curriculum.

Ethical Considerations

The implementation of the present study has been approved by Süleyman Demirel University Ethics Board (June 28, 2021/99-73705). The researchers have adhered to all ethical principles and rules in the collection, analysis, and reporting of the data for the study.

Conflict of Interest Statement

The authors declare that they have no academic or financial conflicts of interest.

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APPENDICES

Appendix 1

Examples of Open-Ended Problems

Problem 1. You need to fill a sphere with colored liquid. Since you cannot move the sphere, you must fill it using one of the following glasses: cylinder, cone, square pyramid, or square prism.

- All cups and spheres are of equal height.
- The radius lengths of the cylinder, cone, and sphere, the length of one side of the square pyramid, and the size of one side of the square prism are equal.

Choose such a glass that it can fill the sphere with the least number of moves. Explain in detail how you made this choice.

Problem 5. Ayşe is trying to get bigger cubes by combining her small cubes. First, she puts one small cube (Figure 1). She then places two small cubes side by side and places the other small cubes so that the object is a larger cube (Figure 2).

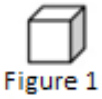


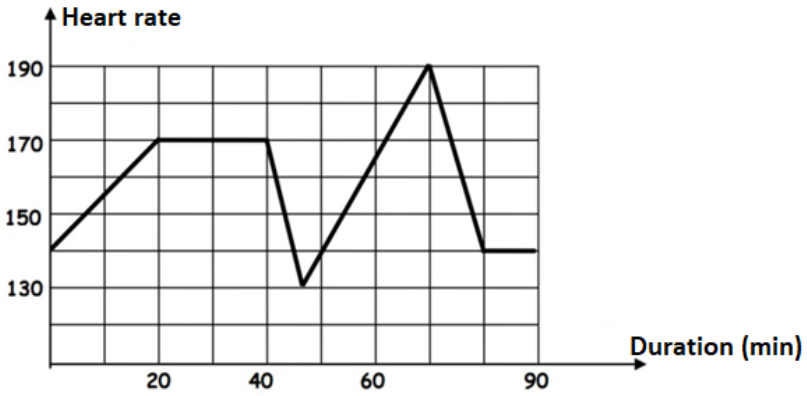
Figure 1


Figure 2

Ayşe wants to calculate how many small cubes are needed for the larger cube that she started by putting five small cubes side by side without adding the individual cubes. How can Ayşe calculate this? Please explain with details.

(Safe heart rate=220 people's age) Minimum (minimum) safe heart rate = safe heart rate x 60% Maximum(max) safe heart rate = safe heart rate x 90%

Problem 10. The rate of our heartbeat is the basic function of our life. For the continuation of our life in a healthy way, our heart rate should beat in the ranges given below:



First 20 min. Serhat's heart throughout, ...

Between 20 minutes and 40 minutes, Serhat's heart is.....

Between 45 and 70 minutes, Serhat's heart, ...

If our heart beats within the range of this formula, our heart health is in place. Below is the heart rate graph of 25-year-old Fenerbahçe football player Serhat during a match. Using the safe heart rate calculation above, interpret whether the player's heart regularly beats during the match by relating it to the graph.

Appendix 2

Reasoning Skills Inventory

Sayın katılımcı,
Sizden istenen aşağıda verilen ifadelerin her birini bilimsel bir çalışma yaptığınızı düşünerek değerlendirdikten sonra her ifadeye ne düzeyde katıldığınızı belirtmenizdir.
Katılımınız ve samimi cevaplarınız için çok teşekkür ederiz.

No	Düşünme Becerileri ile İlgili Görüşler	%20	%40	%60	%80	%100
1	Problem çözerken bilindik fikirler yerine yenilerini tercih ederim.	1	2	3	4	5
2	Problem çözerken mevcut yöntemler yerine yeni yöntemleri tercih ederim.	1	2	3	4	5
3	Problem çözerken orijinal olmak benim için önemlidir.	1	2	3	4	5
4	Bir problemin çözümünde farklı yaklaşımları kullanırım.	1	2	3	4	5
5	Araştırma yaparken orijinal çözüm yolları kullandığımda verimli olacağımı düşünürüm..	1	2	3	4	5
6	Bir araştırmada değişkenler arasında bir ilişki bulacağım fikriyle hareket ederim.	1	2	3	4	5
7	Doğadaki her şey bir ölçüte göre belirlenerek kıyaslanabilir.	1	2	3	4	5
8	Karmaşık gibi görünen durumların arka planında bile bir oran olduğunu düşünürüm.	1	2	3	4	5
9	Evrende olgular göreceli olsalar bile hepsinin altında değişmez bir gerçekliğin bulunduğuna inanırım.	1	2	3	4	5
10	Bir problemle karşılaştığımda ilişkisiz gibi görünen iki kavram arasında bile bir ilişki ortaya çıkarabilirim.	1	2	3	4	5
11	Bilimsel araştırma yapmayı bir saati incelemeye benzetebiliriz. Bu süreçte önemli olan o saatin parçalarını tespit etmek ve işlevlerini anlamaktır.	1	2	3	4	5
12	Araştırma yaparken ölçebildiğim her şey zihnimde netleşmiş demektir.	1	2	3	4	5
13	Bir problemle karşılaştığımda birden çok doğru cevap olabileceğini düşünerek hareket ederim.	1	2	3	4	5
14	Genelde problemlere yaklaşırken "Doğru" ve "Yanlış" yoktur sadece olabildiğince fazla cevap vardır anlayışıyla hareket ederim.	1	2	3	4	5
15	Araştırma yaparken, süreç içerisinde karşılaşılabilecek olasıbütün durumların belirlenmesine öncelik veririm.	1	2	3	4	5
16	Araştırma yaparken, konuyla ilişkili bütün bakış açılarını dikkate alırım.	1	2	3	4	5
17	Araştırma yaparken, problemle ilgili ipuçlarını kullanarak olabildiğince çok senaryo üreterek o olayı daha iyi anlarım.	1	2	3	4	5
18	Çözümüne dair güçlü tahminlerimin bulunduğu araştırmalar beni daha çok cezbeder.	1	2	3	4	5
19	Yapacağım çalışmanın estetik yapısını önemserim.	1	2	3	4	5

20	Araştırma yaparken, ilişki kurmayı gerektiren problemlerle çalışmayı tercih ederim.	1	2	3	4	5
21	Araştırma yaparken, karşılaştırma yapmayı gerektiren problemlerle çalışmayı tercih ederim.	1	2	3	4	5
21	Bir kavramı anlayabilmenin ona benzeyen başka bir kavramla olan benzerliklerini bulmak olduğuna inanırım.	1	2	3	4	5
23	Araştırma yaparken, eş zamanlı meydana gelen olgular arasındaki ilişkiyi bulmaya çalışırım.	1	2	3	4	5

Appendix 3

Prepared Game Videos

Video 1. Guess What?

Video 2. Finding the Pair

Video 3. Who Knows the Numbers Wins