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The Role of Intelligence-Based Teaching Methods in Developing Non-Routine Problem-Solving Skills among Elementary School Students

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Abstract

The purpose of this study was to investigate the effects of instructional practices based on intelligence games on the non-routine problem-solving skills of fourth-grade elementary school students. The study employed a nested design, one of the mixed-methods research designs. The primary data in the study were obtained from the experimental process (single-group pretest/post-test). The study sample included 22 fourth-grade students (12 girls, 10 boys) attending an elementary school in Rize in Turkey. The students were selected via convenience sampling, one of the purposive sampling methods. The intervention plan, which included intelligence games, was implemented over 40 sessions spanning 10 weeks. It was found that the non-routine problem-solving skills of elementary school students improved after the teaching intervention, based on the post-test scores. Additionally, the students reported that activities based on brain games contributed to their problem-solving skills, their ability to develop alternative solutions, and their strategy-development skills. Based on these results, it is suggested that future studies could be designed to test the role of such activities in developing students' various skills.

Keywords: *elementary school students; intelligence games; problem solving*

Introduction

The rapid changes and transformations of everyday lives in today's world have led to an increase of problems people are faced with (Yavuz et al., 2017). These changes also necessitate the development and transformation of the learning processes (Tian et al.,

2022). In this context, problem-solving skills must be made an indispensable part of the school curriculum (Pöhner & Hennecke, 2018). Many countries have recognised the importance of teaching them in schools (Kaitera & Harmoinen, 2022). However, it has been emphasized that students' problem-solving skills are below the minimum proficiency level (Suseelan et al., 2023), that students need support in developing these skills (Ömeroğlu et al., 2009), and that educating individuals in this regard is extremely necessary (Gelbal, 1991). It is emphasized that activity-based teaching practices can be incorporated into the education and training process to develop problem-solving skills (Ömeroğlu et al., 2009; Suseelan et al., 2023). Such activity-based teaching practices have a significant impact on the development of students' problem-solving skills (Kaitera & Harmoinen, 2022). The instruction based on games, where students' active participation is high, can be more efficient in developing problem-solving skills than traditional methods (Supriatna et al., 2019). According to this perspective, more effective teaching processes can be designed in order for students to gain problem-solving skills (Tambychik & Meerah, 2010).

Possessing higher-order thinking skills is essential to effectively cope with challenges encountered in everyday life (Ngang et al., 2014). In this regard, individuals must develop problem-solving skills in order to addres a plan to solve the problem, implementing the developed plan, and checking its implementation (Polya, 1997).

Problems are divided into routine and non-routine problems. Routine problems are exercise problems that can be solved by using processing skills. Four processing skills are sufficient to solve these types of problems. Non-routine problems, on the other hand, are problems that can be solved by using higher-level thinking skills beyond procedural skills when there is no ready-made solution plan for the problem. These problems resemble problems encountered in daily life (Altun, 2018). In solving non-routine problems, individuals use their prior knowledge to reach a solution (Weswood, 2011). Students should solve non-routine problems via higher-order thinking skills such as analysis, synthesis, and evaluation (Suseelan et al., 2023).

Difficulties may be encountered in developing problem-solving skills in the learning environments where active participation is limited (Tambychik & Meerah, 2010). Learning environments and activities that encourage students' active participation can be organized during the process of developing this skill (Schoenfeld, 2017). In such learning activities, students are given the opportunity to find solutions to problems on their own (Gelbal, 1991; Polya, 1997). Intervention plans can be designed accordingly to support the development of students' problem-solving skills (Suseelan et al., 2023).

Games can significantly contribute to students' mental development by ensuring their active participation in the learning process. Enriching the learning process with games that students are interested in can make learning more effective and enjoyable (Chou, 2016). The idea of using games in instruction has come to the fore in recent times (Kafai, 2006), and there is consensus that such interventions should be an integral part of curricula (Freitas & Oliver, 2006). Using educational brain games in the learning process has been emphasized (Erwin, 2003). Such game-based teaching,

which has become an important component of the curriculum, has a strong potential in making learning more engaging and enjoyable (Charlier & Fraire, 2013).

Educational games can be used to contribute to the effective and meaningful learning processes of students. The teaching based on brain games can be used at different stages of education and training processes, ensuring students' active participation and increased learning motivation (Mubaslat, 2012; Norte & Lobo, 2008). In intelligence games applications, individuals develop their own unique solutions (Devecioğlu & Karadağ, 2014), gain different perspectives (Marangoz & Demirtaş, 2017), and thus improve their reasoning skills (Bottino et al., 2014). Additionally, research findings indicate that intelligence games significantly contribute to the development of students' cognitive, affective, and psychomotor skills (Hsieh & Chen, 2019). Intelligence games, which make significant contributions to the development of students' mental capacities, present gamified versions of all kinds of problems (Ministry of National Education [MoNE], 2013). Students try to find solutions to these problems by developing different approaches to overcome them (Şanlıdağ & Aykaç, 2021).

There are few studies on the implementation of educational designs based on intelligence games, and the majority of these studies have aimed to examine the effect of such games on different variables (Özdevecioğlu & Hark-Söylemez, 2021). However, with the addition of intelligence games to the curriculum as an elective course at the secondary school level by the Turkish Ministry of National Education, the importance given to such practices has increased (MoNE, 2013). As the importance of intelligence games in education has been recognized, the number of conducted studies has also risen.

The current research is significant because it shows the positive influence of using intelligence games in the teaching process on developing non-routine problem-solving skills in fourth-grade elementary school students. While there are studies in the literature indicating that intelligence games improve students' problem-solving skills (Esentaş, 2021; Kurbal, 2015; Şanlıdağ & Aykaç, 2021), it is evident that the number of studies examining the effect of such applications on non-routine problem-solving skills is quite limited. The present study is important in terms of determining the effectiveness of intervention plans that include such teaching based on brain games in developing problem-solving skills, which are among important skills emphasized in primary school curricula. The intervention plan that includes teaching practices based on intelligence games developed within the scope of the current research will contribute to the literature in terms of providing an alternative practice that facilitates the development of students' non-routine problem-solving skills.

The present study aimed to examine the effect of teaching based on intelligence games on the non-routine problem-solving skills of fourth-grade elementary school students. To this end, the following questions were addressed:

1 Is there a significant difference between the pretest and post-test scores of 4th grade elementary school students on the non-routine problem-solving achievement test?
2 What are the opinions of 4th grade elementary school students regarding the teaching practices based on intelligence games?

Methodology

A mixed-methods study was conducted to determine the supportive role of instructional practices based on intelligence games in the development of elementary school students' non-routine problem-solving skills.

In the study, it was deemed appropriate to use a nested design, in which qualitative data are used to explain and support the quantitative data. In the nested design, a weak experimental design (single-group pretest/post-test) was used to collect the primary (quantitative) data. The extent to which post-test scores differ from pretest scores is determined (Büyüköztürk et al., 2013), and the role of the intervention is identified in the outcomes (Creswell, 2020).

An experimental design was developed in this study to obtain primary data on the role of instruction based on intelligence games in the development of non-routine problem-solving skills. Secondary data were used to support the data obtained from the primary source. Qualitative data obtained from interviews conducted with students after the experimental process were used as a secondary data source to support and explain the data derived from the experimental outcomes. This approach enabled a better understanding of the research question by leveraging the strengths of both quantitative and qualitative data.

Research group

In this study, fourth-grade students attending a public elementary school in the province of Rize in Turkey were included in the research sample. The pilot study was conducted with 20 students from the same class, including 10 female and 10 male students. The principal intervention was carried out with 22 students from a different class of the same school, consisting of 12 female and 10 male students. An intervention program consisting of intelligence games was implemented for 10 weeks with the group participating in the main study. Additionally, a post-intervention focus group discussion was held with the students to determine their views on the teaching processes based on intelligence games.

Data collection process

In the present study, the Non-Routine Mathematical Problem Solving Test-1 (multiple choice) and the Non-Routine Mathematical Problem Solving Test-2 (open-ended)—both developed by the researchers as part of a doctoral dissertation—were used as pretests and post-tests to collect quantitative data. Pretests and post-tests were administered ten weeks apart. To collect qualitative data within the scope of the study, a semi-structured interview form developed by the researchers was used. After administering the non-routine achievement tests developed within the scope of the study as pre-tests prior to the intervention, the researchers administered them again as post-tests upon its completion. Additionally, following the intervention, focus group interviews were conducted with the students using the semi-structured interview form developed by the researchers.

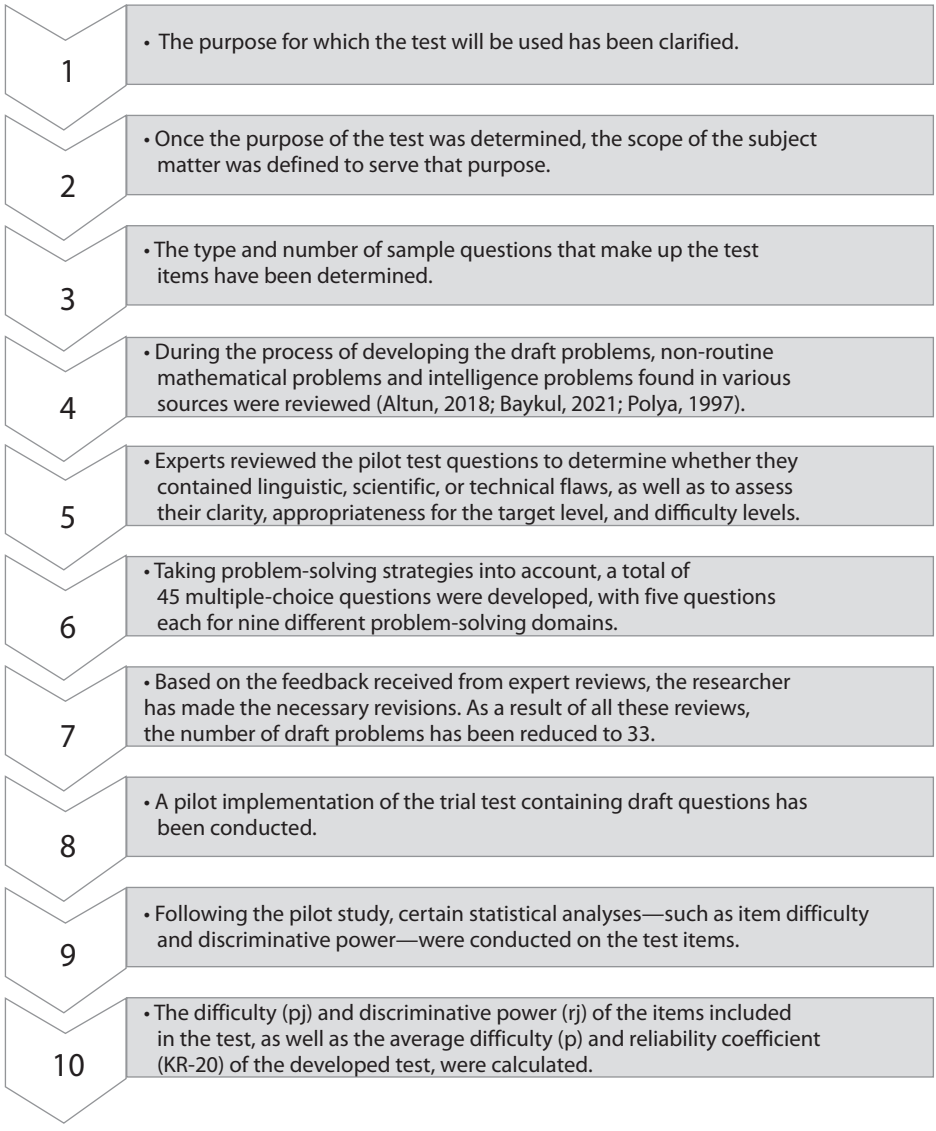


Figure 1. The Process of Developing a Test for Non-Routine Mathematical Problem-Solving Skills

Data collection tools

Quantitative data collection tools

Multiple-Choice Non-Routine Mathematical Problem-Solving Skills test (NRMPSAT 1)

An achievement test containing multiple-choice questions was developed to determine the level of students' non-routine mathematical problem-solving skills. The developed achievement test was administered to students as a pretest and post-test after undergoing validity and reliability studies. The test development process

followed the steps used by Tekin (2010), Baykul (2000) and Güler (2018) in their test development processes. This process is shown in Figure 1.

A total of 112 fourth-grade students attending three different elementary schools were recruited for the administration of the pilot test (consisting of a total of 33 items identified following expert review). The administration process was completed over two days, and data were collected. Item analyses were conducted based on the obtained test results. As a result of all these analyses, it was determined that 22 questions met the desired levels of item difficulty and discriminative power. The item difficulty and discriminative power indices for the problems included in the test are shown in Table 1.

Table 1
Difficulty and Discriminative Power of the Test Items

Article No	Item Difficulty Index	Article Discrimination Index	Article No	Item Difficulty Index	Article Discrimination Index
+1	0.47	0.55	+18	0.56	0.61
+2	0.55	0.77	+19	0.35	0.32
+3	0.37	0.55	-20	0.18	0.23
-4	0.39	0.19	-21	0.82	0.29
+5	0.50	0.74	+22	0.40	0.48
+6	0.68	0.58	+23	0.50	0.61
+7	0.73	0.48	-24	0.18	0.23
+8	0.74	0.45	-25	0.31	0.23
-9	0.24	0.03	+26	0.42	0.52
-10	0.03	0.06	+27	0.42	0.52
+11	0.44	0.68	+28	0.29	0.45
+12	0.45	0.52	+29	0.42	0.52
+13	0.27	0.35	-30	0.44	0.16
+14	0.35	0.45	-31	0.16	0.06
+15	0.24	0.35	+32	0.53	0.48
-16	0.06	0.13	-33	0.23	0.13
+17	0.53	0.68			

+Items included in the test, - Items excluded

Based on the data in Table 1, problems with a discrimination index below 0.3 (11 problems) were removed from the test as a result of item analysis. The three problems with a discrimination index between 0.30 and 0.39 were included in the test without any corrections because they had a fairly good discrimination index. Therefore, it was determined that the item discrimination indices of the problems included in the NRMPSAT test were at a sufficient level. Regarding the difficulty of the questions included in the test, it is seen that the difficulty index of nine problems is greater than 0.5, while the difficulty index of 13 problems is less than 0.5. The item analysis results of the problems in the NRMPSAT are shown in Table 2.

Table 2
Results of the Item Analysis of the NRMPSAT

Problem No	N	pj	pj:Value Ranges	Result	rj	rj:Value Ranges	Result	P	KR- 20
1	112	0.47	.20≤ pj≤80	Moderate difficulty	0.55	.40≤ rj	Very good item	.46<.50 It can be said that the test is difficult for students.	.70≤.82≤.90 The test developed for this purpose is highly reliable.
2	112	0.55	.20≤ pj≤80	Moderate difficulty	0.77	.40≤ rj	Very good item		
3	112	0.37	.20≤ pj≤80	Moderate difficulty	0.55	.40≤ rj	Very good item		
4	112	0.5	.20≤ pj≤80	Moderate difficulty	0.74	.40≤ rj	Very good item		
5	112	0.68	.20≤ pj≤80	Moderate difficulty	0.58	.40≤ rj	Very good item		
6	112	0.73	.20≤ pj≤80	Moderate difficulty	0.48	.40≤ rj	Very good item		
7	112	0.74	.20≤ pj≤80	Moderate difficulty	0.45	.40≤ rj	Very good item		
8	112	0.44	.20≤ pj≤80	Moderate difficulty	0.68	.40≤ rj	Very good item		
9	112	0.45	.20≤ pj≤80	Moderate difficulty	0.52	.40≤ rj	Very good item		
10	112	0.27	.20≤ pj≤80	Difficult	0.35	.30≤ rj≤.39	Quite good item		
11	112	0.35	.20≤ pj≤80	Moderate difficulty	0.45	.40≤ rj	Very good item		
12	112	0.24	.20≤ pj≤80	Difficult	0.35	.30≤ rj≤.39	Quite good item		
13	112	0.53	.20≤ pj≤80	Moderate difficulty	0.68	.40≤ rj	Very good item		
14	112	0.56	.20≤ pj≤80	Moderate difficulty	0.61	.40≤ rj	Very good item		
15	112	0.35	.20≤ pj≤80	Moderate difficulty	0.32	.30≤ rj≤.39	Quite good item		
16	112	0.4	.20≤ pj≤80	Moderate difficulty	0.48	.40≤ rj	Very good item		
17	112	0.5	.20≤ pj≤80	Moderate difficulty	0.61	.40≤ rj	Very good item		
18	112	0.42	.20≤ pj≤80	Moderate difficulty	0.52	.40≤ rj	Very good item		
19	112	0.42	.20≤ pj≤80	Moderate difficulty	0.52	.40≤ rj	Very good item		
20	112	0.29	.20≤ pj≤80	Difficult	0.45	.40≤ rj	Very good item		
21	112	0.42	.20≤ pj≤80	Moderate difficulty	0.52	.40≤ rj	Very good item		
22	112	0.53	.20≤ pj≤80	Moderate difficulty	0.48	.40≤ rj	Very good item		

Table 2 shows the item discrimination index (rj) and item difficulty (pj) values of the NRMPSAT, the average difficulty of the test (P), and the Kuder Richardson

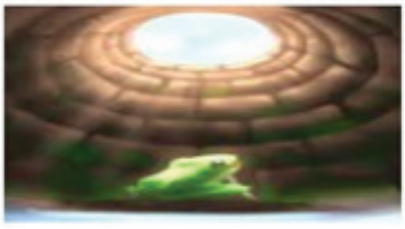
20 (KR-20) reliability coefficient results. When examining the item difficulty levels of the problems included in the test, three problems were found to be difficult, while the remaining 19 problems were found to be of medium difficulty. In addition, it was determined that the item discrimination index of the 19 problems included in the test was .40≤rj, and that the discrimination index of these problems was very good. The discrimination indices of the three problems in the test were found to be in the range of .30≤rj≤.39, and the discrimination levels of these problems were determined to be quite good (Güler, 2018; Tekin, 2010; Turgut & Baykul, 2011). The average difficulty of the test was calculated as 46, and it was found that the test had an average level of difficulty (Tekin, 2010). The KR-20 reliability value of the NRMPSAT was .82, indicating that the test had a high level of reliability. In addition to item analyses, the necessary procedures were carried out in accordance with the steps outlined by Güler (2018) to determine the validity and reliability of the NRMPSAT.

A) Scope validity

These are studies conducted to determine the degree to which the measurement tool can represent the subject area. Researchers attempt to determine the level at which the problems prepared within the scope of the test represent the subject area using indicator tables (Büyüköztürk et al., 2013; Güler, 2018; Tekin, 2010). In this context, the level to which the problems in the test prepared in the current study represented the purpose and strategies used in the problem-solving process has been evaluated within the framework of the problem-solving strategies of Polya (1997), Altun (2005) and Baykul (2021).

b) Face validity

The fact that the test appears to measure the trait it is intended to measure, that it contains information about the subject area, and that the items in the test provide information about the subject area at first glance (Büyüköztürk et al., 2013) relates to the test's face validity. The fact that the test developed within the scope of this study was designed according to mathematical problem-solving strategies, that the instructions were prepared accordingly, and that the test's overall appearance reflected the subject area demonstrates that the test possesses face validity. Sample questions related to the developed multiple-choice non-routine problem-solving achievement test are presented in Figure 2.



A frog at the bottom of a 12-meter deep well is trying to get out. With each jump, it climbs up 3 meters, but because the walls are slippery, it slides down 1 meter after every jump. On which jump will the frog be able to get out of the well?

A)5 B)4 C)6 D)7

Figure 2. Sample Question for the Multiple-Choice Achievement Test

Open-Ended Non-Routine Mathematical Problem-Solving Ability test (NRMPSAT 2)

An open-ended test was designed to assess the effectiveness of teaching based on intelligence games in developing students' non-routine problem-solving skills. The questions included in the test require higher-order thinking skills, which can be effective in measuring students' non-routine problem-solving skills. The questions included in the test were developed using different sources in line with the problem-solving strategies developed by Polya (1997), Altun (2018) and Baykul (2021). Based on all this, 11 open-ended problems were generated to identify students' non-routine problem-solving skills. The researcher presented these draft problems to the experts in the field of primary education for their opinion. In addition, the researcher applied these open-ended problems to fourth-grade elementary school students and obtained the necessary feedback. After all these applications, two problems were removed from the open-ended achievement test because they were above the students' level. In line with the opinions of field experts, an open-ended test consisting of nine questions was created, with one question for each problem-solving strategy. The second pilot application of the prepared test was conducted with 78 students to determine whether the problems were appropriate for the students' level and understood. The answer sheets of 30 randomly selected students were reviewed by two different evaluators, and inter-rater consistency values were calculated. To minimize inconsistencies among the reviewers before scoring (Turgut & Baykul, 2011), a detailed scoring key was created, thereby significantly ensuring the validity and reliability of the test (Atılgan et al., 2017). In the analysis of the responses obtained from the open-ended achievement test developed by the researcher, the graded scoring key developed by Baki (2015) was used. The evaluation criteria developed to identify problem-solving stages were used. The inter-rater reliability coefficient was calculated using the answer key. In this context, the levels used in the analysis of the open-ended NRMPSAT are presented in Table 3.

In analysing the problems in the open-ended test, the responses were evaluated by two different experts using the scoring key above. The evaluators graded each student's responses using a scoring key (rubric). As a result of the evaluation, a maximum of four points could be awarded for each question, yielding a total of 36 points. Sample questions related to the developed open-ended, non-routine problem-solving achievement test are provided in Figure 3.

The consistency coefficient among evaluators was calculated to determine the reliability of the developed open-ended achievement test. The closeness of the scores between evaluators, that is, the similarity of the scores given by the evaluators, indicates that the reliability of the measurement tool is high (Büyüköztürk et al., 2013). The Cohen Kappa (κ) method was used to calculate the consistency between scorers. Based on this, the consistency value between the scores given by two different evaluators for the same question was examined. This value, normally in range from -1.00 to +1.00, was found to be close to +1.00, which indicates good inter-rater reliability and shows

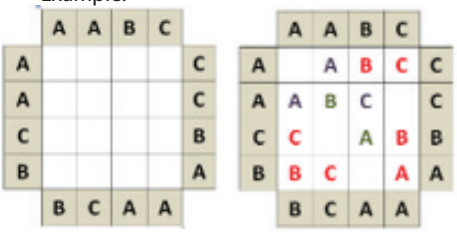
Table 3

Levels Used to Analyse Responses to the Open-Ended Section of the NRMPSAT and Explanatory Descriptions for These Levels

Comprehension Level	Definition of the Level	Understanding the Problem	Planning (Selecting a Strategy)	Implementing the Plan	Evaluation
0-I don't understand	There is no answer, almost no correct answer, or no answer at all	The failure to make any effort to understand the problem	The inability to select any strategy	The inability to reach a solution	Not knowing how the result will be verified
1-Specific misconception	Answers containing illogical or inaccurate information	Failure to understand the problem	Choosing an inappropriate strategy	Implementing an inappropriate or incorrect solution	Partial validation of the results
2-Partial understanding accompanied by a specific misconception	The answer contains both correct and incorrect statements	Understanding part of the problem	Selecting a component of the strategy that will help achieve the solution	Part of the solution	Logical validation of the results
3-Partial understanding	Since the answer contains mostly correct information, it is partially correct but insufficient	Identifying the key variables of the problem and analyzing the prerequisites necessary for its solution	Adopting a systematic approach to manage the peace process and establishing a logical framework	The solution steps were generally implemented correctly, though minor deviations were observed at the operational level	Testing the findings within the context of the problem and verifying the consistency of the solution to a limited extent
4-Full understanding	The answer is completely correct and comprehensive	Full understanding of the problem	Selecting a strategy that will lead to an appropriate solution	Reaching an appropriate and correct solution	Solving the problem and the new problem derived from it

The letters outside the diagram indicate the first letters visible when viewed from that direction. As shown in the example below, fill in the blank diagram below by using each of the letters given in the upper-left corner of the diagram exactly once in the rows and columns.

Example:



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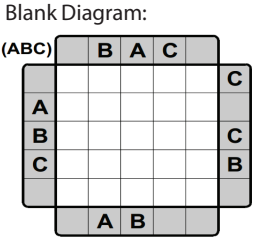

Figure 3. Sample Question for an Open-Ended Achievement Test

(ABC)

no disagreement between evaluators (Şencan, 2005). Within the scope of the current research, it was determined that the inter-rater reliability values of the open-ended achievement test developed to determine non-routine problem-solving skills ranged between .712 and .953. These values indicate that the inter-rater reliability of the questions included in the open-ended achievement test was high.

Qualitative data collection tools

Interview form

In the current study, a focus group interview was conducted with students after the teaching interventions based on intelligence games to obtain their views on the process. The researchers developed a semi-structured interview form for this purpose. To ensure the validity of the qualitative data, the opinion of a field expert was sought to determine the suitability of the interview form prepared for this purpose. In addition, the research process was reported in detail to ensure its validity. To ensure the reliability of the research, the students' thoughts on the implementation process were expressed with codes. Furthermore, the data obtained from the interviews were coded by two independent coders to examine the inter-coder agreement. The agreement index between was 85%. Consensus was reached on 44 of the 52 created codes. Following the implementation process, focus group interviews were conducted with fourth-grade elementary school students in two separate sessions, with 11 students in each group.

Data analysis

Multiple-choice and open-ended achievement tests developed by the researcher were administered to the study group as a pretest. Following this process, the intervention plan—which included 10 weeks of instruction based on intelligence games—was implemented. After the intervention, the tests administered as pretests were re-administered as post-tests. Given that the small sample size would not ensure a normal distribution of the data (Drew et al., 1996), it was decided to use the non-parametric Wilcoxon Signed-Rank Test (Can, 2017) to determine the mean differences between the two measurements. Therefore, for the analysis of data obtained from the pre and post-test applications of the non-routine mathematical problem-solving achievement tests, the arithmetic mean (X) and Wilcoxon Signed-Rank Test were used. The necessary analyses were conducted using the SPSS 20.0 software package.

Content analysis was used to analyse the data obtained from the focus group interviews conducted with students following the implementation. The focus group interviews, which were conducted in two sessions, were recorded using a voice recorder. The collected data were transcribed into text on a computer and analysed using the MAXQDA software. The content analysis method, in which similar data points are grouped and organized into themes, was employed in the data analysis. The qualitative data obtained within the scope of the study are presented in diagrams, and the codes with the highest frequency are supported by direct quotes, where students are coded as 1, 2, 3, etc.

The implementation process

The teaching plan based on intelligence games was conducted for a total of ten weeks, entailing two sessions of two hours per week (four hours per week—160 minutes. A researcher with a degree in intelligence games was responsible for the implementation. A sample implementation plan for the teaching activities based on intelligence games developed within the scope of this research is presented in Table 4.

Table 4
Sample Implementation Plan

Participants	Fourth-grade elementary school students
Time	2 lessons (40'+40') + 2 lessons (40'+40')
Purpose	Beginner Level • These are games in which progress is made by evaluating the given clues directly or in different orders. Intermediate Level • These are games involving short trials where incorrect options are eliminated through trial and error. • These are games where game-specific basic strategies are employed. Advanced Level • These are games that require extensive trial and error to reach a solution. • These are games in which players develop and employ their own strategies specific to the game.
Skill	Non-routine mathematical problem-solving skills
Location	Intelligence games class
Material	Intelligence games materials, worksheets, pencil, A4 paper, computer, PowerPoint
Preparation	1 A PowerPoint presentation about the games has been prepared. 2 Game materials for the activities have been prepared. 3 Worksheets for the activities have been prepared. 4 Since some game materials were not available in sufficient quantities, the researcher created a version of the game adapted for A4 paper.
Process	Lesson 1 • Puzzle games were taught to students using a PowerPoint presentation. • Logic games: Information were provided about Sudoku, regional Sudoku, and shaped and colored Sudoku games. • It was explained that Sudoku is a game that develops thinking and reasoning skills. Additionally, students were informed that it is a game that enhances concentration, fosters creativity, improves hand-eye coordination, and relaxes the mind. • Explanations were provided regarding the fact that Sudoku is a single-player game and that there were Sudoku grids with 4x4, 6x6, 9x9, 12x12, 16x16, and 20x20 square layouts. • It was explained that they did not need a friend or an opponent to play; instead, they could compete against themselves by timing themselves or increasing the difficulty level. • After the instructions were given, a worksheet consisting of easy-level Sudoku puzzles (Sudoku Activity 1) was distributed to the students to solve.

- It was explained that Sudoku is a game that develops thinking and reasoning skills. Additionally, students were informed that it is a game that enhances concentration, fosters creativity, improves hand-eye coordination, and relaxes the mind.
- Explanations were provided regarding the fact that Sudoku is a single-player game and that there were Sudoku grids with 4x4, 6x6, 9x9, 12x12, 16x16, and 20x20 square layouts.
- It was explained that they did not need a friend or an opponent to play; instead, they could compete against themselves by timing themselves or increasing the difficulty level.
- After the instructions were given, a worksheet consisting of easy-level Sudoku puzzles (Sudoku Activity 1) was distributed to the students to solve.
- Additionally, the necessary explanations regarding regional Sudoku were provided to the students. It was noted that all the rules of classic Sudoku applied.
- However, it was emphasized that the regions were not divided in a regular pattern as in classic Sudoku. It was explained that the key point to note was that each number had to be used exactly once in every region divided by thick lines.

Process

Lesson 2

Geometric puzzle games: It was said that tangram, Katamino/Pinomino, and pattern games would be taught.

- Information about tangram was provided.
- It was explained that tangram is a puzzle game based on assembling seven geometric pieces to create various shapes.
- Students were asked a few questions. These included:

1 What is the relationship between the tangram pieces?
2 Which pieces do you use to make a square and a rectangle?
3 Which pieces have sides of equal length?

Lesson 3

The necessary information about the Katamino game was provided. Students were informed about the rules of the game.

- It was stated that there were 12 pentaminos (pieces).
- It was stated that there were 5 small red pieces and 3 small brown pieces.
- It was noted that when two people played, the divider stick should be placed in the space between 6 and 7.
- Students were given the necessary time to play the game. Additionally, the instructor checked whether the difficulty levels had been completed and whether the correct piece had been selected during the game.

Lesson 4

The necessary information about the pattern game was provided.

- It was described as a highly enjoyable matching game designed to find stones with the same pattern among stones featuring different patterns.

Results

1. Although students initially found it a bit challenging since they encountered many of the games for the first time, they were able to overcome the problems presented in the games as time went on.
2. Some games required advanced computational skills. In this context, some students struggled because they lacked the necessary prior knowledge.
3. Some students struggled during the process because the games involved problems outside their usual routine.
4. Since the problem scenarios presented in the game required advanced skills, some initial difficulties were encountered.

Results

This section of the study presents findings regarding the role of teaching practices based on intelligence games in the non-routine problem-solving skills of fourth-grade elementary school students.

Table 5
Descriptive Statistics Regarding Pretest and Post-test Scores on the Tests of Non-Routine Mathematical Problem-Solving Skills

	Pretest				Post-test			
	n	$\bar{x}$	Median	Ss	n	$\bar{x}$	Median	Ss
NRMPSAT (Multiple Choice Test)	22	9,59	8,50	4,61	22	15,90	16,00	3,81
NRMPSAT (Open-ended test)	22	15,00	15,00	6,85	22	29,50	29,50	2,24

Table 5 shows that the mean pretest score on the Multiple-Choice Test of Non-Routine Mathematical Problem-Solving Skills was $\bar{x} = 9.59$, while the mean post-test score was $\bar{x} = 15.90$. For the open-ended achievement test, the mean pretest score was $\bar{x} = 15.00$, while the mean post-test score was $\bar{x} = 29.50$. Upon examining the table, it is observed that the mean post-test scores were higher than the mean pre-test scores for both tests. This indicates that the implemented intervention plan improved students' ability to solve non-routine problems.

Table 6
Results of the Wilcoxon Signed-Rank Test Analysis of Pretest and Post-test Scores on the Multiple-Choice Achievement Test

Pretest/Post-test	n	Average rank	Sum of the sequence	z	p	r value
Negative sequence	0	0,00	0,00			
Positive sequence	20	10,50	210,00	-3,926	,00	0,83
Equal	2					

According to the data in Table 6, there is a significant difference in favour of the post-test scores compared to pretest scores (multiple-choice) of fourth-grade elementary school students ($z = -3.926$, $p < 0.05$). Effect size is one of the measures indicating the significance of the difference between the groups. According to Cohen (1988), an r value of 0.5 or higher indicates that a study has a large effect. In the current study, the effect size was calculated as 0.83, which indicates a moderate effect. It can therefore be interpreted that the intervention plan incorporating teaching practices based on intelligence games supported the development of students' non-routine problem-solving skills.

According to the data in Table 7, there is a significant difference in favour of the post-test scores compared to pretest scores (open-ended) of fourth-grade elementary school students ($z = -4.110$, $p < 0.05$), and the effect of this significance is found to be moderate ($r = 0.87$). This finding suggests that teaching methods that incorporate intelligence games supported the development of students' non-routine problem-solving skills.

Table 7
Results of the Wilcoxon Signed-Rank Test Analysis of Pretest and Post-test Scores on the Open-Ended Achievement Test

Pretest/Post-test	n	Average rank	Sum of the sequence	Z	p	r value
Negative sequence	0	0,00	0,00			
Positive sequence	22	11,50	253,00	-4,110	,00	0,87
Equal	0					

Student opinions on teaching based on intelligence games

The data obtained from interviews with students are presented in the form of figures.

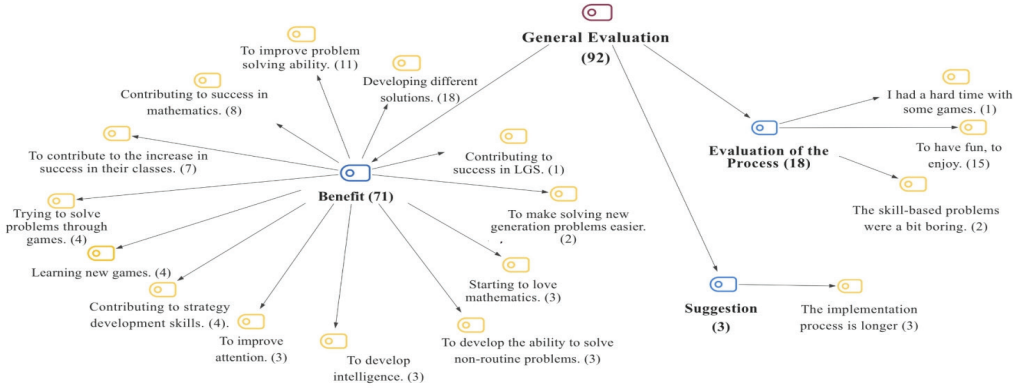

Figure 5. Opinions of Fourth-Grade Elementary School Students Regarding Intelligence Games Applications

The statements regarding elementary school students' views on teaching based on intelligence games have been grouped into three categories: evaluation of the process, benefits, and recommendations.

On this topic, student 8 said: "*The process was generally good. These types of activities have helped us solve problems more easily. The board games were especially good. For example, the pyramid game was easier and more enjoyable than the others.*"

Figure 6. Fourth-grade elementary school students' views on the skills they acquired through teaching based on intelligence games

It is visible from Figure 6 that fourth-grade elementary school students expressed the benefits from learning through intelligence games as developing different solution paths (f:15), problem solving (f:12), and strategy development (f:10). On this issue, student 5 stated: *"I saw that I developed different approaches in the games. I realized how to use these approaches when solving problems."*

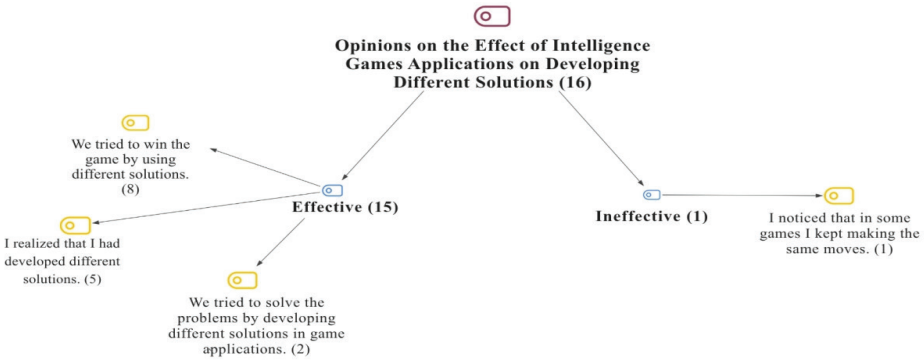

Figure 7. Fourth-grade elementary school students' views on the contribution of teaching via intelligence games to their problem-solving skills

An examination of Figure 7 reveals that most students indicated that teaching methods based on the implemented intelligence games were effective in developing problem-solving skills. On this topic, student 8 said: *"We encountered problems outside the ones we are used to, and I noticed that I got faster at solving these problems. It improved my problem-solving skills. I started solving problems more easily."*

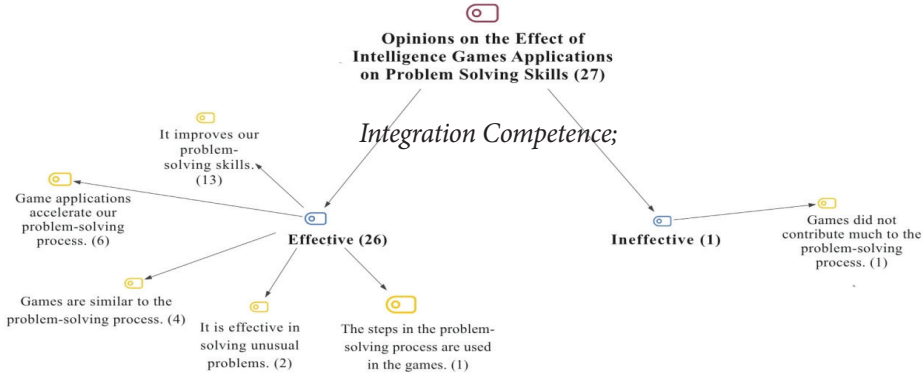

Figure 8. Fourth-grade elementary school students' views on the contribution of teaching via intelligence games to their ability to develop different solution paths

As shown in Figure 8, the majority of students indicated that such applications were effective in developing different solution strategies. On this topic, student 10 mentioned: *"While playing intelligence games, I realized that there was more than one solution. For example, in Target 5, I tried to trap my opponent and won the game this way."*

Discussion

In this study, a significant difference was found between the pretest and post-test scores obtained by elementary school students on an achievement test designed to assess their non-routine mathematical problem-solving skills, with the post-test scores being significantly higher. This finding may indicate that the intervention plan, which incorporated teaching practices based on intelligence games, contributed to the development of students' non-routine problem-solving skills. This finding may stem from the fact that, during the instructional process based on intelligence games, students developed solution strategies by employing diverse problem-solving processes in the games presented to them. This serves as evidence that instructional practices based on intelligence games provide significant contributions to the development of non-routine problem-solving skills among elementary school students. This result of the study aligns with the findings of Devecioğlu and Karadağ (2014), who reported that the use of intelligence games enhanced students' problem-solving skills and that students overcame the problems they encountered by employing various solution strategies in such activities. The finding that the use of intelligence game applications may be effective in the process of developing problem-solving skills has also been observed in studies in the literature (Demirel, 2015; Erdoğan et al., 2017; Marangoz & Demirtaş, 2017). However, contrary to the widespread belief cited in the literature, there are also studies that found no effect of game-based intervention plans on students' cognitive development. In this regard, Simons et al. (2016) noted in their study that there is no comprehensive evidence to suggest that game-based intervention plans improve students' cognitive performance.

The present study concluded that an intervention plan incorporating teaching practices based on intelligence games contributed to the development of students' non-routine problem-solving skills. This may stem from the fact that students utilized problem-solving processes to overcome various problem situations while playing intelligence games. In such teaching practices, students may encounter problems that require multiple solution paths beyond ordinary (routine) problems. By developing different solution paths to tackle such non-routine problems and attempting to find solutions to the problems they encounter, students can develop their non-routine problem-solving skills. The findings obtained in this study align with the results of research in the literature. For example, the results of Demirel's (2015) study showed that intelligence games made significant contributions to students' problem-solving skills and academic achievement, and they are in line with the results of the current study. Similarly, in a study conducted with second-grade elementary students, Marangoz (2018) emphasized that such games contributed to students' cognitive skills and imparted important skills to them. However, the findings of Sala et al. (2018), who investigated the effects of computer-based games on students' cognitive abilities, contradict the current research findings, as they concluded that there was no causal relationship found between playing such games and cognitive abilities. There are studies

in the literature that support the current research finding that intelligence games make significant contributions to problem-solving skills. For example, the findings of Akbaş and Baki (2015), indicating that such applications contributed to the development of problem-solving, reasoning, and inquiry skills, and those of Romero et al. (2015), who suggested that intelligence games supported the development of 21st-century skills, align with the results of the current study. In this context, the findings of this study and the research in the literature indicate that applying intelligence games makes significant contributions to the development of problem-solving, develops different perspectives, reasoning, and critical thinking skills.

Another finding obtained from the interviews conducted with students as part of this study is that the implementation of intelligence games significantly influenced the development of students' problem-solving skills and their ability to develop different perspectives. This situation serves as a strong indicator that, during instructional applications of intelligence games, students encounter certain problem situations and utilize problem-solving processes to overcome them. It also suggests that students develop alternative solutions to problems by devising different approaches while playing intelligence games. Along the same lines, Kurbal (2015) found that students taking an intelligence games course improved their problem-solving and reasoning skills. Esentaş (2021) also demonstrated in his research that students indicated such games could be used as educational tools. Bottino et al. (2013) reached a similar conclusion in their study. This finding indicates a strong positive correlation between elementary students' ability to play intelligence games and their academic achievement. In interviews with classroom teachers, Kula (2021) found that teachers believed such applications made significant contributions to learning processes. Ekiçi et al. (2017) noted a consensus on intelligence games being fun and, as such, having the potential of use in teaching and learning processes. The finding from this study that including intelligence games in teaching contributed to the development of students' non-routine problem-solving skills aligns with the findings of studies in the literature. All these results suggest that teaching and learning practices based on intelligence games can be utilized in the process of developing non-routine problem-solving skills.

Conclusion and recommendations

In the present study, it was concluded that instructional practices based on intelligence games serve as an effective teaching tool that contributes to the development of non-routine problem-solving skills in elementary school students.

The recommendations developed based on the research findings are as follows:

- Long-term longitudinal studies can be designed to examine the impact of implementing intelligence games-based activities on students' non-routine problem-solving skills.
- Research can be conducted on the effects of intervention plans incorporating intelligence-games teaching practices on various skills.
- Experimental studies can be conducted on the contribution of intelligence games to verbal subjects.

- Care must be taken to ensure there is sufficient number of intelligence games provided during implementation. To prevent the instructor from encountering classroom management issues, enough intelligence games must be prepared to accommodate all students.
- For process-based intelligence games—a type of intelligence game—students' prior knowledge must be adequately developed before implementation.
- Based on the knowledge and skills students gain from educational intervention plans that incorporate intelligence games, a curriculum incorporating intelligence games can be developed for the elementary school level, and a course can be added. Moreover, intelligence games courses can be organized as exercise workshops.
- Extended longitudinal studies with larger sample groups could be conducted to investigate the development of non-routine problem-solving skills among elementary school students through activities based on intelligence games.

Limitations of the study

1 The experimental study did not include a control group. Therefore, the study only involved the experimental group students who participated in the intervention process.
2 The education provided under the designed intelligence game-based activity plans was limited to a ten-week intervention plan.
3 The study's sample was limited to 22 fourth-grade elementary school students.
4 The study's data collection tools are limited to achievement tests and an interview form created by the researchers.

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Uloga metoda poučavanja temeljenih na inteligenciji u razvoju vještina rješavanja nerutinskih problema učenika osnovne škole

Sažetak

Svrha ove studije jest istražiti učinke nastavnih praksi temeljenih na inteligencijskim igrama na vještine nerutinskoga rješavanja problema učenika četvrtoga razreda osnovne škole. Studija je koristila ugniježđeni dizajn, jedan od istraživačkih dizajna mješovite metode. Primarni izvor podataka za studiju čine podatci dobiveni iz eksperimentalnoga procesa (pred-posttest s jednom skupinom). Uzorak istraživanja sastojao se od 22 učenika četvrtoga razreda (12 djevojčica i 10 dječaka) osnovne škole u Rizeu u Turskoj, odabranih primjenom metodičkoga uzorkovanja po praktičnosti, jedne od ciljnih metoda uzorkovanja. Intervencijski plan, koji je uključivao igre za razvoj inteligencije, proveden je u 40 sesija tijekom 10 tjedana. Na temelju nalaza istraživanja, zaključeno je da su se vještine učenika osnovne škole za rješavanje nerutinskih problema poboljšale u korist rezultata posttestiranja unutar ispitivane skupine tijekom razdoblja intervencije. Dodatno, učenici su izvijestili da su takve aktivnosti doprinijele njihovim vještinama rješavanja problema, njihovoj sposobnosti razvijanja alternativnih rješenja i njihovim vještinama razvijanja strategija. Na temelju ovih rezultata, predlaže se da bi buduća istraživanja mogla biti osmišljena kako bi se testirala uloga takvih aktivnosti u razvijanju različitih vještina učenika.

Ključne riječi: *logičke igre; rješavanje problema; učenici osnovne škole*

Uvod

Brze promjene i transformacije koje se danas događaju dovele su do povećanja problema s kojima se ljudi suočavaju (Yavuz i sur., 2017). Te promjene i transformacije također zahtijevaju razvoj i transformaciju procesa učenja (Tian i sur., 2022). U tome kontekstu, vještine rješavanja problema moraju postati neizostavan dio školskoga kurikula (Pöhner i Hennecke, 2018). Mnoge zemlje navode da je ta vještina važna vještina koju bi trebalo poučavati u školama (Kaitera i Harmoinen, 2022). Međutim, naglašeno je da su vještine rješavanja problema učenika ispod minimalne razine osposobljenosti

(Suseelan i sur., 2023), da učenici trebaju podršku u razvoju tih vještina (Ömeroğlu i dr., 2009) i da je obrazovanje pojedinaca iznimno nužno (Gelbal, 1991). Naglašava se da se prakse poučavanja temeljene na aktivnostima mogu uključiti u obrazovni i odgojni proces kako bi se razvile vještine rješavanja problema (Ömeroğlu i sur., 2009; Suseelan i sur., 2023). Takve prakse poučavanja temeljene na aktivnostima imaju značajan utjecaj na razvoj učenikovih vještina rješavanja (Kaitera i Harmoinen, 2022). U nastavnim primjenama temeljenim na igrama, pri čemu je sudjelovanje učenka aktivno, poučavanje ove vještine može biti učinkovitije od tradicionalnih metoda (Supriatna i sur., 2019). S toga gledišta mogu se osmisliti učinkovitiji nastavni procesi za stjecanje ove vještine (Tambychik i Meerah, 2010).

Posjedovanje vještina višega reda razmišljanja nužno je za učinkovito suočavanje s izazovima s kojima se susrećemo u svakodnevnom životu (Ngang i sur., 2014). U tom pogledu, pojedinci moraju razviti vještine rješavanja problema kako bi se pozabavili i prevladali razne probleme s kojima se suočavaju (Riyadi-Syarifah i Nikmaturrohmah, 2021). S obzirom na sve to, razvijanje ove vještine uključeno je u obrazovne ciljeve mnogih zemalja (Arkan-Sezgin, 2019). Razvijanje vještina rješavanja problema u matematici je vrlo važno (Asman i Markovits, 2009). Vještine rješavanja problema nisu samo tema o kojoj se raspravlja i koja se naglašava u matematici. To je važna vještina koju koristimo u svakom području našega svakodnevnog života (Posamentier i Krulik, 2016). Problemi i neizvjesnosti na koje nailazimo u svakodnevnome životu maifestiraju se kao situacije koje zahtijevaju rješavanje (Gelbal, 1991), dok se proces uklanjanja te neizvjesnosti i uspostavljanje reda naziva rješavanjem problema (Altun, 2018). Sposobnost rješavanja problema, složen proces koji uključuje određene korake (Wardani i sur., 2018), sastoji se od četiriju faza (Polya, 1997). To su sljedeće faze: razumijevanje problema, razvijanje plana za rješavanje problema, provedba razvijenoga plana rješenja i provjera provedenoga plana rješenja (Polya, 1997).

Problemi se dijele na rutinske i nerutinske probleme. Rutinski problemi su zadatci koje je moguće riješiti primjenom obradnih vještina. Četiri obradne vještine dovoljne su za rješavanje ovih vrsta problema. Nerutinski problemi, s druge strane, su problemi koje je moguće riješiti primjenom viših misaonih vještina koje nadilaze proceduralne vještine kada za problem ne postoji gotov plan rješavanja. Ove vrste problema slične su problemima s kojima se susrećemo u svakodnevnome životu (Altun, 2018). Pri rješavanju nerutinskih problema pojedinci koriste svoje prethodno znanje kako bi došli do rješenja (Weswood, 2011). Učenicima bi trebalo zadavati nerutinske probleme čime im se omogućuje razvoj i primjena viših misaonih vještina kao što su analiza, sinteza i evaluacija (Suseelan i sur., 2023).

Mogu se pojaviti poteškoće u razvoju vještina rješavanja problema u okružjima za učenje u kojim je aktivno sudjelovanje ograničeno (Tambychik i Meerah, 2010). Okružja za učenje i aktivnosti koje potiču aktivno sudjelovanje učenika mogu se organizirati tijekom procesa razvoja ove vještine (Schoenfeld, 2017). U takvim se nastavnim aktivnostima učenicima pruža prilika da sami pronađu rješenja za probleme

(Gelbal, 1991; Polya, 1997). Na temelju toga mogu se osmisliti planovi intervencije za podršku razvoju studentskih vještina rješavanja problema (Suseelan i sur., 2023).

Igre mogu značajno doprinijeti mentalnome razvoju učenika osiguravajući njihovo aktivno sudjelovanje u procesu učenja. Uključivanje učenika u proces učenja primjenom raznolikih vrsta igrivih aktivnosti može pridonijeti većoj učinkovitosti i ugodnosti učenja. (Chou, 2016). Ideja korištenja igara u procesima učenja došla je u prvi plan u posljednje vrijeme (Kafai, 2006) i postoji konsenzus da bi se takve primjene trebale uvrstiti u kurikul (Freitas i Oliver, 2006). Na temelju toga naglašeno je da se igre inteligencije, koje su jedna od vrsta edukativnih igara, mogu koristiti u procesu učenja (Erwin, 2003). Takve primjene nastave temeljene na igrama, koje su postale važna komponenta nastavnoga programa, imaju snažan potencijal da učenje učine zanimljivijim i ugodnijim (Charlier i Fraire, 2013).

Edukativne igre mogu se koristiti za doprinos učinkovitim i smislenim procesima učenja učenika. Ove vrste aplikacija za poučavanje temeljenih na igrama mogu se koristiti u različitim fazama obrazovnih i procesa osposobljavanja. Ove vrste procesa učenja, koje osiguravaju aktivno sudjelovanje učenika, mogu povećati njihovu motivaciju za učenjem (Mubaslat, 2012; Norte i Lobo, 2008). U aplikacijama igara inteligencije, koje su jedna od vrsta igara, pojedinci razvijaju vlastita jedinstvena rješenja (Devecioğlu i Karadağ, 2014), stječu različite perspektive (Marangoz i Demirtaş, 2017) i time poboljšavaju svoje vještine rasuđivanja (Bottino i sur., 2014). Dodatno, istraživanja pokazuju da igre inteligencije značajno doprinose razvoju kognitivnih, afektivnih i psihomotornih vještina učenika (Hsieh i Chen, 2019). Igre inteligencije, koje značajno doprinose razvoju mentalnih sposobnosti učenika, predstavljaju gamificirane inačice svih vrsta problema (Ministarstvo nacionalnog obrazovanja [MoNE], 2013). Učenici pokušavaju pronaći rješenja za te probleme razvijajući različite pristupe kako bi ih prevladali (Şanlıdağ i Aykaç, 2021).

Broj studija u kojima su razvijeni dizajni s aplikacijama aktivnosti temeljenim na igrama inteligencije vrlo je mali. Velika većina ograničenoga broja provedenih studija imala je za cilj ispitati učinak takvih igara na različite varijable (Özdevecioğlu i Hark-Söylemez, 2021). Međutim, važnost takvih praksi porasla je nakon što je Tursko ministarstvo nacionalnoga obrazovanja uvelo igare inteligencije u kurikul kao izborni predmet u srednjoškolski kurikul (MoNE, 2013). Kako je važnost igara inteligencije u obrazovanju prepoznata, broj provedenih studija također je počeo rasti.

Trenutačno istraživanje značajno je jer pokazuje da aplikacije za poučavanje temeljene na igrama inteligencije mogu proces poučavanja za razvoj vještina rješavanja nerutinskih problema učenika četvrtoga razreda osnovne škole učiniti učinkovitijim i ugodnijim. Iako postoje studije u literaturi koje ukazuju na to da igre inteligencije poboljšavaju vještine rješavanja problema učenika (Esentaş, 2021; Kurbal, 2015; Şanlıdağ i Aykaç, 2021), očito je da je broj studija koje ispituju učinak takvih aplikacija na vještine rješavanja nerutinskih problema prilično ograničen. Ova je studija važna za utvrđivanje učinkovitosti planova intervencije koji uključuju takve nastavne primjene

temeljene na igrama inteligencije u razvoju vještina rješavanja problema, koje su među važnim vještinama naglašenima u kurikulu osnovne škole. Plan intervencije koji uključuje nastavne prakse temeljene na igrama inteligencije, razvijen u sklopu ovoga istraživanja, doprinijet će literaturi kao alternativna praksa za razvijanje vještina učenika za rješavanje nerutinskih problema.

Svrha je ove studije ispitati učinak nastavnih aplikacija temeljenih na igrama inteligencije na vještine rješavanja nerutinskih problema učenika četvrtoga razreda osnovne škole. U tu su svrhu postavljena sljedeća pitanja:

1. Postoji li značajna razlika između rezultata predtestiranja i posttestiranja učenika četvrtog razreda osnovne škole na testu postignuća u nerutinskom rješavanju problema?
2. Koja su mišljenja učenika četvrtoga razreda osnovne škole o nastavnim praksama temeljenim na i igrama inteligencije?

Metodologija

Provedena je studija kombiniranih metoda kako bi se utvrdila potporna uloga nastavnih praksi temeljenih na igrama inteligencije u razvoju vještina učenika osnovne škole za rješavanje nerutinskih problema.

U studiji je smatrano prikladnim koristiti ugniježđeni dizajn, u kojem se kvalitativni podatci koriste za objašnjenje i potporu kvantitativnim podatcima. U ugniježđenom dizajnu korišten je slab eksperimentalni dizajn (jedna skupina, predtest–posttest) za prikupljanje primarnih (kvantitativnih) podataka. U ovome se dizajnu utvrđuje u kojoj se mjeri rezultati posttesta razlikuju od rezultata predtesta (Büyüköztürk i sur., 2013) te se identificira uloga intervencije u ishodima (Creswell, 2020).

U ovoj je studiji razvijen eksperimentalni dizajn kako bi se utvrdila uloga nastave temeljene na igrama inteligencije kao primarnoga izvora podataka o vještinama rješavanja nerutinskih problema. U tom se dizajnu sekundarni podatci koriste za potporu podatcima dobivenima iz primarnoga izvora. Kvantitativni podatci dobiveni iz intervjua provedenih s učenicima nakon eksperimentalnoga procesa korišteni su kao sekundarni izvor podataka za potporu i objašnjenje podataka izvedenih iz eksperimentalnih ishoda. Ovaj je pristup omogućio bolje razumijevanje istraživačkoga pitanja iskorištavanjem prednosti kvantitativnih i kvalitativnih podataka.

Istraživačka skupina

U ovome istraživanju učenici četvrtoga razreda javne osnovne škole u pokrajini Rize u Turskoj uključeni su kao odgovarajuća istraživačka skupina. Pokusno istraživanje provedeno je s 20 učenika iz istoga razreda, od kojih je 10 bilo učenica i 10 učenika. Glavna primjena provedena je s 22 učenika iz drugoga odjela iste škole, od kojih je 12 bilo učenica i 10 učenika. Intervencijski program koji se sastojao od igara za poticanje inteligencije provodio se 10 tjedana s grupom koja je sudjelovala u glavnoj studiji. Dodatno je s učenicima održana diskusija u fokus grupi nakon intervencije

kako bi se utvrdila njihova mišljenja o nastavnim primjenama temeljenim na igrama za poticanje inteligencije.

Proces prikupljanja podataka

U ovoj studiji korišteni su Test rješavanja nerutinskih matematičkih problema-1 (višestruki izbor) i Test rješavanja nerutinskih matematičkih problema-2 (otvorena pitanja) – oba su razvili istraživači u sklopu doktorske disertacije – kao predtesti prije intervencije i kao posttesti nakon intervencije radi prikupljanja kvantitativnih podataka.

Između predtestova i posttestova protekao je desetotjedni intervencijski period. Za prikupljanje kvalitativnih podataka u okviru studije korišten je polustrukturirani upitnik koji su razvili istraživači. Nakon što su nerutinski testovi postignuća razvijeni u okviru studije primijenjeni kao predtestovi prije intervencije, istraživači su ih ponovno proveli kao posttestove po završetku intervencije. Dodatno, nakon intervencije, s učenicima su provedeni intervjui u fokus grupama koristeći polustrukturirani upitnik koji su razvili istraživači.

Alati za prikupljanje kvantitativnih podataka

Test vještina rješavanja nerutinskih matematičkih problema s višestrukim izborom (NRMPSAT -1-).

Razvijen je test postignuća koji sadrži pitanja s višestrukim izborom kako bi se utvrdila razina razvijenosti vještina učenika za rješavanje nerutinskih matematičkih problema. Razvijeni test postignuća primijenjen je na učenicima kao predtest i posttest nakon provedenih studija valjanosti i pouzdanosti. Proces razvoja testa slijedio je korake koje su koristili Tekin (2010), Baykul (2000) i Güler (2018) u svojim procesima razvoja testa. Taj je proces prikazan na Slici 1.

Slika 1

Ukupno je 112 učenika četvrtoga razreda iz triju različitih osnovnih škola uključeno u provedbu pokusnoga testa (koji se sastojao od ukupno 33 stavke identificirane nakon stručne revizije). Proces provedbe završen je u dva dana, a prikupljeni su podatci. Analize stavki provedene su na temelju dobivenih rezultata testa. Kao rezultat svih tih analiza utvrđeno je da je 22 pitanja zadovoljilo željene razine težine stavke i diskriminacijske moći. Indeksi težine stavke i diskriminacijske moći za zadatke uključene u test prikazani su u Tablici 1.

Tablica 1

Na temelju podataka u Tablici 1, problemi s indeksom diskriminacije ispod 0,3 (11 problema) uklonjeni su iz testa kao rezultat analize stavki. Tri problema s indeksom diskriminacije između 0,30 i 0,39 uključena su u test bez ikakvih korekcija jer su imali prilično dobar indeks diskriminacije. Na temelju toga utvrđeno je da su indeksi diskriminacije stavki problema uključenih u NRMPSAT test na dovoljnoj razini. Gledajući indekse težine pitanja uključenih u test, vidi se da je indeks težine

u 9 problema veći od 0,5, dok je u 13 problema manji od 0,5. Rezultati analize stavki problema u NRMPSAT-u prikazani su u Tablici 2.

Tablica 2

Tablica 2 prikazuje vrijednosti indeksa diskriminacije stavke (rj) i težine stavke (pj) za NRMPSAT, prosječnu težinu testa (P) i rezultate koeficijenta pouzdanosti Kuder-Richardson 20 (KR-20). Prilikom ispitivanja razina težine stavki problema uključenih u test utvrđeno je da su tri problema bila teška, dok je preostalih devetnaest problema ocijenjeno kao srednje teška. Osim toga, utvrđeno je da je indeks diskriminacije stavki devetnaest problema uključenih u test bio ≥0,40 i da je indeks diskriminacije tih problema bio vrlo dobar. Indeksi diskriminacije triju problema u testu bili su u rasponu od ≥ 0,30 do ≤ 0,39, a razine diskriminacije tih problema ocijenjene su kao prilično dobre (Güler, 2018; Tekin, 2010; Turgut i Baykul, 2011). Prosječna težina testa izračunata je na 46 te je utvrđeno da test ima prosječnu razinu težine (Tekin, 2010). KR-20 vrijednost pouzdanosti NRMPSAT-a iznosila je 0,82, što ukazuje na visoku razinu pouzdanosti testa. Osim analize stavki, provedene su potrebne procedure u skladu s koracima koje je naveo Güler (2018) kako bi se utvrdila valjanost i pouzdanost NRMPSAT-a.

a) Valjanost pokrivenosti

To su studije koje se provode kako bi se utvrdila mjera u kojoj mjerni alat može predstavljati područje predmeta. Istraživači pokušavaju utvrditi razinu na kojoj problemi pripremljeni u sklopu testa predstavljaju područje predmeta koristeći tablice indikatora (Büyüköztürk i sur., 2013; Güler, 2018; Tekin, 2010). U tome kontekstu, razina na kojoj zadatci u testu pripremljenom u ovoj studiji predstavljaju svrhu i strategije korištene u procesu rješavanja problema procijenjena je u okviru strategija rješavanja problema Polyje (1997), Altuna (2005) i Baykula (2021).

b) Sadržajna valjanost

Činjenica da se čini kako test mjeri osobinu koju je zamišljeno mjeriti, da sadrži informacije o području predmeta te da stavke u testu pružaju informacije o tome području na prvi pogled (Büyüköztürk i sur., 2013) odnosi se na sadržajnu valjanost testa. Činjenica da je test razvijen u sklopu ove studije osmišljen u skladu sa strategijama rješavanja matematičkih problema, da su upute pripremljene u skladu s tim te da cjelokupni izgled testa odražava područje predmeta dokazuje da test posjeduje nominalnu valjanost. Primjeri pitanja iz razvijenoga testa postignuća za rješavanje nerutinskih problema s višestrukim izborom prikazani su na Slici 2.

Slika 2

Test sposobnosti rješavanja nerutinskih matematičkih problema otvorenoga tipa (NRMPSAT-2-)

Razvijen je test otvorenoga tipa za procjenu učinkovitosti nastavnih primjena temeljenih na igrama inteligencije na vještine učenika za rješavanje nerutinskih problema. Pitanja

uključena u test su takvoga tipa da zahtijevaju više razine mišljenja, što može biti učinkovito u mjerenju vještina učenika za rješavanje nerutinskih problema. Pitanja uključena u test razvijena su korištenjem različitih izvora u skladu sa strategijama rješavanja problema koje su razvili Polya (1997), Altun (2018) i Baykul (2021). Na temelju svega toga generirano je 11 otvorenih zadataka za utvrđivanje učenikovih vještina rješavanja nerutinskih problema. Istraživač je te nacrte zadataka predstavio stručnjacima iz područja osnovnoga obrazovanja kako bi dobio njihovo stručno mišljenje. Osim toga, istraživač je primijenio te otvorene zadatke na učenike četvrtoag razreda osnovne škole i dobio potrebne povratne informacije. Nakon svih tih primjena, dva su zadatka uklonjena iz testa postignuća otvorenoga tipa s obrazloženjem da su bila iznad razine učenika. U skladu s mišljenjima stručnjaka iz prakse, izrađen je test otvorenoga tipa koji se sastojao od 9 pitanja, s po jednim pitanjem za svaku strategiju rješavanja problema. Druga pokusna primjena pripremljenoga testa provedena je sa 78 učenika kako bi se utvrdilo jesu li zadatci bili primjereni razini učenika i jesu li ih razumjeli. Odgovorne listove 30 nasumično odabranih učenika pregledala su dva različita ocjenjivača te su izračunate vrijednosti interocjenjivačke konzistentnosti. Kako bi se smanjile nesuglasice među ocjenjivačima prije bodovanja (Turgut i Baykul, 2011), izrađen je detaljan ključ za bodovanje, čime se značajno osigurava valjanost i pouzdanost testa (Atılgan i sur., 2017). U analizi odgovora dobivenih iz otvorenoga testa postignuća koji je razvio istraživač korišten je ocjenjivački ključ koji je razvio Baki (2015.). Korišteni su kriteriji za ocjenjivanje razvijeni za identifikaciju faza rješavanja problema. Koeficijent pouzdanosti međuocjenjivača izračunat je pomoću ključa za ocjenjivanje. U tome kontekstu, razine korištene u analizi otvorenoga NRMPSAT-a prikazane su u Tablici 3.

Tablica 3

Pri analizi problema u otvorenome testu odgovore su ocijenila dva različita stručnjaka koristeći gore navedeni ključ za bodovanje. Ocjenjivači su odgovore svakog učenika ocijenili pomoću rangirane ljestvice (rubrike). Kao rezultat evaluacije, za svako pitanje moglo se dodijeliti najviše 4 boda, što ukupno iznosi 36 bodova. Primjeri pitanja vezanih uz razvijeni test postignuća za rješavanje otvorenih, nerutinskih problema prikazani su na Slici 3.

Slika 3

Koeficijent konzistentnosti među ocjenjivačima izračunat je kako bi se utvrdila pouzdanost generiranoga testa postignuća otvorenoga tipa. Bliskost ocjena među ocjenjivačima, odnosno drugim riječima, sličnost ocjena koje su dali ocjenjivači, ukazuje na to da je pouzdanost mjernoga alata visoka (Büyüköztürk i sur., 2013). Za izračun dosljednosti između ocjenjivača korištena je Cohenova Kappa (κ) metoda. Na temelju toga ispitana je vrijednost dosljednosti između bodova koje su dodijelila dva različita ocjenjivača za isto pitanje. Ova vrijednost, koja se može kretati od -1,00 do +1,00, ako je bliska +1,00, ukazuje na dobru međuosjenjivačku pouzdanost. Ova

vrijednost je snažan pokazatelj da ne postoji neslaganje između ocjenjivača (Şencan, 2005). U okviru ovoga istraživanja utvrđeno je da su vrijednosti pouzdanosti među ocjenjivačima otvorenoga testa postignuća razvijenoga za utvrđivanje vještina rješavanja nerutinskih problema bile u rasponu od ,712 do ,953. Ove vrijednosti ukazuju na to da je pouzdanost među ocjenjivačima pitanja uključena u otvoreni test postignuća visoka.

Alati za prikupljanje kvalitativnih podataka

Obrazac za intervju

U ovoj studiji proveden je intervju s fokusnom grupom s učenicima nakon nastavnih primjena temeljenih na igri inteligencije kako bi se dobila njihova mišljenja o procesu. U tome su kontekstu istraživači razvili polustrukturirani obrazac za intervju. Kako bi se osigurala valjanost podataka dobivenih iz kvalitativnih podataka, zatraženo je mišljenje stručnjaka iz prakse kako bi se utvrdila prikladnost pripremljenoga obrasca za intervju. Osim toga, istraživački je proces detaljno dokumentiran kako bi se osigurala valjanost istraživanja. Kako bi se osigurala pouzdanost istraživanja, mišljenja učenika o procesu provedbe izražena su kodovima. Nadalje, podatci dobiveni iz intervjua kodirala su dva neovisna procjenjivača kako bi se ispitala suglasnost među njima. Indeks suglasnosti između dvaju različita procjenjivača iznosio je 85 %. Postignut je konsenzus o 44 od 52 stvorena koda. Nakon procesa implementacije provedeni su intervjui s fokus grupama s učenicima četvrtoga razreda osnovne škole u dvjema odvojenim sesijama, s po 11 učenika u svakoj grupi.

Analiza podataka

Testovi postignuća s višestrukim izborom i otvorenim pitanjima, koje je razvio istraživač, provedeni su na istraživačkoj skupini kao predtest. Nakon toga je proveden plan intervencije, koji je uključivao 10 tjedana nastave temeljene na igrama za razvoj inteligencije. Nakon intervencije, testovi koji su provedeni kao predtest ponovno su provedeni kao posttest. S obzirom na to da mali broj ispitanika ne bi osigurao normalnu raspodjelu podataka (Drew i sur., 1996), odlučeno je koristiti neparametarski Wilcoxonov test ranga sa znakom (Can, 2017) za utvrđivanje razlika između dvaju mjerenja. Stoga su za analizu podataka dobivenih iz pred- i posttestova nerutinskih testova postignuća u rješavanju matematičkih problema korišteni aritmetička sredina (X) i Wilcoxonov test ranga sa znakom. Potrebne analize provedene su pomoću softverskoga paketa SPSS 20.0.

Korištena je analiza sadržaja za analizu podataka dobivenih iz intervjua s fokus grupama provedenih s učenicima nakon provedbe. Intervjui s fokus grupama, koji su održani u dvije sesije, snimljeni su diktafonom. Prikupljeni podatci transkribirani su u tekst na računalu i analizirani pomoću softvera MAXQDA. U analizi podataka primijenjena je metoda analize sadržaja, pri čemu su slične točke podataka grupirane i organizirane u teme. Kvantitativni podatci dobiveni u sklopu studije prikazani su dijagramima, a kodovi s najvišom frekvencijom potkrijepljeni su izravnim citatima. Prilikom predstavljanja izravnih citata, učenici su kodirani kao "1, 2, 3, ...".

Proces provedbe

Nastavni plan temeljen na igrama inteligencije proveden je u ukupnom trajanju od deset tjedana, a sastojao se od dva dvosatna termina tjedno (4 sata tjedno – 160 minuta). Provedbu je izvršio jedan od istraživača, koji je završio studij iz područja igara inteligencije. Primjer plana provedbe za aktivnosti učenja temeljene na igrama inteligencije, razvijen unutar okvira ovoga istraživanja, prikazan je u Tablici 4.

Tablica 4

Rezultati

U ovome dijelu studije prikazuju se nalazi o ulozi nastavnih praksi temeljenih na igrama inteligencije u vještinama rješavanja nerutinskih problema učenika četvrtoga razreda osnovne škole.

Tablica 5

Tablica 5 pokazuje da je prosječna ocjena na predtestiranju testa s višestrukim izborom za vještine rješavanja nerutinskih matematičkih problema iznosila ($\bar{x}$ = 9,59), dok je prosječna ocjena na posttestiranju iznosila ($\bar{x}$ = 15,90). Za test postignuća s otvorenim pitanjima, prosječna ocjena na predtestiranju iznosila je ($\bar{x}$ = 15,00), dok je prosječna ocjena na posttestiranju iznosila ($\bar{x}$ = 29,50). Promatrajući tablicu, uočava se da su prosječne ocjene na posttestiranju za obaju testova bile više od prosječnih ocjena na predtestiranju. To ukazuje da je provedeni plan intervencije poboljšao sposobnost učenika za rješavanje nerutinskih problema.

Tablica 6

Prema podatcima u Tablici 6 postoji značajna razlika u korist rezultata posttesta u usporedbi s rezultatima predtestiranja (višestruki izbor) učenika četvrtoga razreda osnovne škole ($z = -3{,}926$, $p < 0{,}05$). Veličina učinka jedna je od mjera koja ukazuje na značajnost razlike između skupina. Prema Cohenu (1988), vrijednost r od 0,5 ili više ukazuje na to da studija ima velik učinak. U ovoj studiji veličina učinka izračunata je na 0,83. To ukazuje na to da studija ima umjeren učinak. U tom se kontekstu može protumačiti da plan intervencije koji uključuje nastavne prakse temeljene na igrama inteligencije podržava razvoj učenika u rješavanju nerutinskih problema.

Tablica 7

Prema podtacima u Tablici 7, postoji značajna razlika u korist rezultata posttesta u usporedbi s predtestom (otvorena pitanja) učenika četvrtoga razreda osnovne škole ($z = -4{,}110$, $p < 0{,}05$), a učinak te značajnosti pokazuje umjerenu veličinu ($r = 0{,}87$). Ovaj nalaz može se protumačiti tako da intervencijski plan, koji uključuje metode poučavanja temeljene na igrama inteligencije, doprinosi razvoju vještina učenika u rješavanju nerutinskih problema.

Mišljenja učenika o primjeni poučavanja temeljenoga na igrama inteligencije

Podatci dobiveni iz intervjua s učenicima prikazani su u obliku grafikona.

Slika 5

Izjave učenika osnovne škole o stavovima prema aplikacijama za poučavanje temeljenim na igrama inteligencije grupirane su u tri kategorije: „Procjena procesa", „Prednosti" i „Preporuke".

O ovoj temi učenik 8 je rekao: „Proces je općenito bio dobar. Ove vrste aktivnosti pomogle su nam da lakše rješavamo probleme. Društvene igre bile su posebno dobre. Na primjer, igra piramide bila je lakša i zabavnija od ostalih."

Slika 6

Analizom Slike 6 utvrđeno je da su učenici četvrtoga razreda osnovne škole postignuća (vještine) koja su stekli u primjenama igara inteligencije izrazili kao razvijanje različitih putanja rješavanja (f:15), rješavanje problema (f:12) i razvoj strategije (f:10). O toj temi učenik 5 izjavio je: „Primijetio sam da sam u igrama razvio različite pristupe. Shvatio sam kako te pristupe koristiti pri rješavanju problema."

Slika 7

Pregled slike 7 otkriva da je većina studenata navela da su metode poučavanja temeljene na takvim igrama inteligencije učinkovite u razvoju vještina rješavanja problema. O toj temi učenik 8 je rekao sljedeće: „Našli smo se suočeni s problemima izvan onih na koje smo bili navikli, i primijetio sam da sam postao brži u rješavanju tih problema. To je poboljšalo moje vještine rješavanja problema. Počeo sam rješavati probleme lakše."

Slika 8

Kao što je prikazano na Slici 8, većina učenika navela je da su takve primjene učinkovite u razvoju različitih strategija rješavanja. O ovoj temi učenik 10 je spomenuo: „Dok sam igrao igre inteligencije, shvatio sam da postoji više od jednoga rješenja. Na primjer, u Cilu 5 pokušao sam uhvatiti protivnika u zamku i tako pobijedio u igri."

Diskusija

U ovoj je studiji utvrđena značajna razlika između rezultata predtesta i posttesta koje su učenici osnovne škole postigli na testu postignuća osmišljenom za procjenu njihovih vještina rješavanja nerutinskih matematičkih problema, pri čemu su rezultati posttesta bili znatno viši.

Ovaj nalaz može ukazivati na to da je plan intervencije, koji je uključivao nastavne prakse temeljene na igrama inteligencije, pridonio razvoju vještina učenika u rješavanju nerutinskih problema. Ovaj nalaz može proizaći iz činjenice da su tijekom nastavnoga procesa temeljenoga na igrama inteligencije učenici razvili strategije rješavanja primjenom

raznolikih procesa rješavanja problema u igrama koje su im bile predstavljene. Ovo služi kao dokaz da nastavne prakse temeljene na igrama inteligencije značajno doprinose razvoju vještina nerutinskoga rješavanja problema učenika osnovne škole. Ovaj nalaz istraživanja usklađen je s nalazima Devecioğlu i Karadağ (2014) koji su izvijestili da primjena igara inteligencije poboljšava vještine rješavanja problema učenika te da učenici, sudjelujući u takvim aktivnostima, probleme na koje nailaze prevladavaju primjenom različitih strategija rješavanja. Zaključak da uporaba aplikacija igara inteligencije može biti učinkovita u procesu razvoja vještina rješavanja problema također je zabilježen u studijama iz literature (Demirel, 2015; Erdoğan i sur., 2017; Marangoz i Demirtaş, 2017). Međutim, suprotno raširenom mišljenju u literaturi, postoje i studije koje ukazuju na to da planske intervencije temeljene na igrama nemaju utjecaja na kognitivni razvoj učenika. U tome pogledu Simons i sur. (2016) u svojoj su studiji primijetili da ne postoje sveobuhvatni dokazi koji bi upućivali na to da planovi intervencije temeljeni na igrama poboljšavaju kognitivne performanse učenika.

Studijom je zaključeno da intervencijski plan koji uključuje nastavne prakse temeljene na igrama inteligencije doprinosi razvoju vještina učenika u rješavanju nerutinskih problema. To može proizlaziti iz činjenice da su učenici koristili procese rješavanja problema kako bi prevladali različite problemske situacije tijekom igranja igara inteligencije. U takvim nastavnim praksama učenici mogu naići na probleme koji zahtijevaju više puteva rješavanja, a ne samo obične (rutinske) probleme. Razvijanjem različitih putova rješavanja takvih nerutinskih problema i pokušajima pronalaženja rješenja za probleme na koje naiđu, učenici mogu razviti svoje vještine nerutinskoga rješavanja problema. Nalazi dobiveni u ovoj studiji usklađeni su s rezultatima istraživanja iz literature. Na primjer, nalaz iz studije Demirela (2015) da igre domišljatosti značajno doprinose vještinama rješavanja problema i akademskome uspjehu učenika usklađen je s rezultatima ove studije. Slično tome, u studiji provedenoj s učenicima drugoga razreda osnovne škole, Marangoz (2018) je naglasio da takve igre doprinose kognitivnim vještinama učenika i prenose im važne vještine. Međutim, nalazi Sale i sur. (2018), koji su istraživali učinke računalnih igara na kognitivne sposobnosti učenika, proturječe nalazima ovoga istraživanja jer su zaključili da ne postoji uzročno-posljedična veza između igranja takvih igara i kognitivnih sposobnosti. U literaturi postoje studije koje podupiru trenutačni istraživački nalaz da igre inteligencije značajno doprinose vještinama rješavanja problema. Na primjer, nalazi Akbaş i Bakija (2015), koji ukazuju da takve primjene doprinose razvoju vještina rješavanja problema, rasuđivanja i istraživanja te nalazi Romera i sur. (2015), koje sugeriraju da igre inteligencije podržavaju razvoj vještina 21. stoljeća, usklađene su s rezultatima ove studije. U tom kontekstu, nalazi ove studije i istraživanja u literaturi ukazuju na to da primjene igara inteligencije značajno doprinose razvoju vještina rješavanja problema, razvijanju različitih perspektiva, rasuđivanja i kritičkoga razmišljanja.

Još jedno otkriće iz intervjua provedenih s učenicima u sklopu ove studije jest da aplikacije inteligentnih igara značajno doprinose razvoju učenikovih vještina rješavanja

problema i sposobnosti razvijanja različitih perspektiva. Ova situacija služi kao snažan pokazatelj da se tijekom nastavnih aplikacija temeljenih na igrama inteligencije učenici susreću s određenim problematičnim situacijama i koriste procese rješavanja problema kako bi ih prevladali. Također sugerira da učenici razvijaju alternativna rješenja za probleme smišljajući različite pristupe tijekom igranja inteligentnih igara. Podržavajući ovaj nalaz istraživanja, Kurbal (2015) je utvrdio da su učenici koji su pohađali tečaj o inteligentnim igrama poboljšali svoje vještine rješavanja problema i zaključivanja. Esentaş (2021) je također u svojem istraživanju pokazao da su učenici naveli kako se takve igre mogu koristiti kao obrazovni alati. Bottino i sur. (2013) došli su do sličnoga zaključka u svojem istraživanju. Ovaj nalaz ukazuje na snažnu pozitivnu korelaciju između sposobnosti učenika osnovnih škola za igranje igara inteligencije i njihovoga akademskog uspjeha. Kula (2021), u intervjuima s razrednim nastavnicima, otkrio je da nastavnici vjeruju da takve aplikacije značajno doprinose procesima učenja. Ekiçi i sur. (2017) primijetili su da postoji konsenzus da su igre inteligencije među zabavnim aplikacijama za učenje koje se mogu koristiti u procesima poučavanja i učenja. Nalaz iz ove studije da aplikacije inteligentnih igara doprinose razvoju učenikovih vještina rješavanja nerutinskih problema usklađen je s nalazima iz literature. Svi ovi rezultati upućuju na to da se nastavne aplikacije temeljene na inteligentnim igrama mogu koristiti u procesu razvijanja vještina rješavanja nerutinskih problema.

Zaključak i preporuke

U ovoj studiji zaključeno je da nastavne prakse temeljene na igrama inteligencije služe kao učinkovit nastavni alat koji doprinosi razvoju vještina rješavanja nerutinskih problema učenika osnovne škole.

Preporuke razvijene na temelju rezultata istraživanja su sljedeće:

- Dugoročne longitudinalne studije mogu se osmisliti kako bi se ispitalo utjecanje implementacija aktivnosti temeljenih na igrama inteligencije na vještine učenika za rješavanje nerutinskih problema.
- Istraživanja se mogu provesti o učincima planova intervencije koji uključuju nastavne prakse temeljene na igrama inteligencije na različite vještine.
- Mogu se provoditi eksperimentalne studije o doprinosu igara inteligencije verbalnim predmetima.
- Potrebno je paziti da tijekom provedbe bude dovoljno igara inteligencije. Kako bi se spriječili problemi s upravljanjem učionicom, treba pripremiti dovoljno igara inteligencije za sve učenike.
- Za procesno orijentirane igre inteligencije — vrstu igara inteligencije — prije provedbe potrebno je adekvatno razviti predznanje učenika.
- Na temelju znanja i vještina koje učenici stječu putem planove intervencije koji uključuju nastavne prakse temeljene na igrama inteligencije, može se razviti kurikul koji uključuje igre inteligencije za razinu osnovne škole i dodati predmet. Dodatno, predmeti s igrama inteligencije mogu se organizirati pod nazivom radionica vježbi.

- Mogle bi se provoditi dugoročne, longitudinalne studije koje uključuju veće skupine ispitanika kako bi se istražio razvoj vještina rješavanja nerutinskih problema učenika osnovne škole primjenom aktivnosti temeljene na igrama inteligencije.

Ograničenja studije

1. Eksperimentalna studija nije uključivala kontrolnu skupinu, stoga je studija ograničena na učenike eksperimentalne skupine koji su sudjelovali u procesu intervencije.
2. Obrazovanje provedeno u okviru osmišljenih aktivnosti temeljenih na igri inteligencije ograničeno je na 10-tjedni interventni plan.
3. Uzorak istraživanja bio je ograničen na 22 učenika četvrtoga razreda osnovne škole.
4. Alati za prikupljanje podataka u istraživanju ograničeni su na testove postignuća i upitnik koji su izradili istraživači.

Napomena

Odobrenje istraživačke etike dobiveno je od Institucionalnog etičkoga odbora [od Odbora za znanstvena istraživanja i publicističku etiku Fakulteta društvenih i humanističkih znanosti Sveučilišta Trabzon, od 28.03.2023. i broj E-81614018-000-2300019108].

Autori izjavljuju da nemaju potencijalnih sukoba interesa u vezi s istraživanjem i autorstvom koji se odnose na ovaj članak.

Ova studija proizlazi iz doktorske disertacije pod naslovom „Utjecaj aplikacija temeljenih na igrama inteligencije na razvoj nerutinskih vještina rješavanja problema učenika osnovne škole“ koju je pripremio Ali TERZİ (2024).