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The effect of mind and intelligence games on primary school students' critical thinking and problem-solving skills

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Abstract

This study investigates the effects of mind and intelligence games on the critical thinking and problem-solving skills of primary school students. The research was designed using an explanatory sequential mixed-methods approach and involved a total of 55 fourth-grade students, 26 in the experimental group and 29 in the control group. Data were collected through a *Personal Information Form, the Critical Thinking Skills Test, and the Problem-Solving Skills Scale*. The analysis of pretest scores indicated no significant differences between the groups, confirming their equivalence prior to the intervention. Over the course of a 12-week intervention, six different mind and intelligence games were implemented with the experimental group. Following the intervention, semi-structured interviews were conducted with 10 students in the experimental group to explore their perceptions and experiences regarding the games. Findings revealed that mind and intelligence games substantially contributed to the development of students' critical thinking skills. In addition, the games significantly enhanced their problem-solving skills. The majority of interviewed students reported positive influences of the games, particularly improvements in attention, engagement with mathematics, and overall academic growth.

Keywords

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Introduction

Thinking is a multifaceted cognitive process that encompasses questioning, evaluating, learning, and understanding. It involves reasoning, drawing inferences, making decisions, and interpreting concepts, events, and situations, while simultaneously engaging emotional, psychological, and physical dimensions of the individual. As an essential human activity, thinking underpins the evaluation of existing knowledge and the generation of new knowledge, supports problem solving, fosters intellectual autonomy, and shapes the future (Güneş, 2012). It facilitates learning by transforming observations and experiences into original ideas.

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The development of thinking skills enhances attention and memory, increases curiosity and motivation for learning, and strengthens mastery in mathematics, language, and visual literacy. Furthermore, it improves abilities such as planning, organizing, and managing details. Competencies like questioning, researching, critiquing, and problem solving are therefore closely tied to the act of thinking. For children and adolescents, developing thinking skills provides independence, self-confidence, awareness, and self-respect, while also enabling a deeper understanding of the society they live in. Rather than accepting events and situations at face value, reasoning, questioning, and offering criticism and solutions depend largely on the maturity of individuals' thinking skills.

In today's complex world, problem-solving ability has become a fundamental competency (Mayer & Wittrock, 2006). The capacity to analyze, evaluate, and design original solutions is a central objective of education. Within the broader effort to cultivate thinking and learning skills in schools, critical thinking and problem-solving are not only strongly associated with academic achievement but are also essential for preparing students to meet the challenges of the future. Accordingly, educators and policymakers have increasingly emphasized the importance of nurturing these skills from an early age, calling for innovative approaches to support their development (Halpern, 2013; Mayer & Wittrock, 2006).

Problem Solving and Critical Thinking in Primary School

Problem solving involves identifying, analyzing, and generating solutions to challenges encountered in a variety of contexts. Developing effective problem-solving skills at the primary school level provides young learners with a strong foundation for future academic achievement and real-world adaptability. In everyday life, students continuously engage in problem-solving activities—such as tackling mathematical problems, interpreting complex texts, or navigating social interactions—that shape their cognitive capacities and adaptive skills (Jonassen, 2010). Experiencing success in devising and applying solutions not only enhances students' self-confidence but also increases their awareness of their own abilities and strengthens their motivation to learn.

In today's rapidly changing world, where diverse challenges are inevitable, children must learn to adapt to new situations and generate alternative solutions. Alongside problem solving, critical thinking is equally essential in the learning process of primary school students. Critical thinking, broadly defined as the ability to analyze and evaluate information and arguments in order to make sound judgments, allows students to approach knowledge with selectivity and skepticism (Halpern, 2013). In an era where information is constantly and intensively transmitted from multiple sources, the capacity to distinguish fact from misinformation, evaluate evidence, and construct persuasive arguments has become indispensable. This process inherently involves critical inquiry, namely, evaluating the validity of information and judgments. Uzun (2022) emphasizes that critical thinking is goal-oriented, requiring decisions about what to believe, questioning the accuracy of acquired knowledge, and examining the assumptions underlying ideas. In this sense, the ability to think critically protects individuals from being swayed by unverified claims or ideas. Inquiry and critique are fundamental to cognitive development in the pursuit of truth (Seferoğlu & Akbıyık, 2006). Individuals who think critically demonstrate openness to diverse perspectives, carefully considering reasons, assumptions, claims, and conclusions. Critical thinking also entails asking the right questions to assess the reliability of knowledge sources. It may be described as the impartial evaluation of the grounds for judgment, enabling individuals to manage experiences effectively and adapt to new circumstances (Ennis, 2011). Snyder and Snyder (2008) argue that critical thinking is a teachable skill and can be fostered through structured practices embedded in the curriculum. They highlight that such growth occurs when students not only focus on content but also apply it meaningfully. Encouraging students to identify and assess alternative viewpoints, make independent decisions, and explore, analyze, and reflect on problems represents a promising pathway for cultivating critical thinking. Indeed, critical thinking has long been recognized as a key predictor of academic achievement and lifelong learning (Norris & Ennis, 1989; Willingham, 2007).

Fostering critical thinking equips primary school students to become competent learners who can engage with complex issues and make informed decisions. Every child who learns to think critically also becomes a more active and responsible participant in society. From a socio-cultural perspective, problem-solving activities are considered central to children's cognitive development (Raslan, 2024; Vygotsky, 1979). Empirical evidence has further shown a positive relationship between problem-solving skills and academic performance among primary school students (Halpern, 1998). Consequently, integrating innovative pedagogical strategies to strengthen students' problem-solving and critical thinking skills has become increasingly important. Among these, mind and intelligence games (board games) have attracted particular interest due to their potential to engage students, foster collaboration, and stimulate cognitive growth. By leveraging the natural appeal of games and puzzles, educators can design interactive learning environments that not only enhance problem-solving but also promote the development of critical thinking skills.

Mind and Intelligence Games

Mind and intelligence games, also referred to as board games in educational contexts, are practical tools used in learning environments to foster cognitive development among students (Gobet & Campitelli, 2006). Examples of such games include checkers, tangram, chess, puzzles, and word searches (Demirel, 2015). These games, evaluated within the framework of educational games, not only provide a concrete approach to learning but also open opportunities for developing specific cognitive skills related to academic achievement (Shute et al., 2015). They consistently offer students active participation and hands-on learning experiences. Through each game, students learn to recognize their strengths and evaluate their self-efficacy in collaboration with peers (Kel & Kul, 2021). While games allow players to enjoy themselves, they also serve as mental exercises that enhance focus and concentration. These games generally consist of cards, cubes, colorful pieces, images, and geometric shapes packed in a box. They are typically made of plastic, cardboard, or wood and can be played either individually or in pairs/groups.

The theoretical framework of cognitive developmental psychology underscores the potential influence of mind and intelligence games on the cognitive skills of primary school students. Piaget's theory of cognitive development emphasizes that knowledge is effectively constructed through personal experiences and interactions with the environment (Huitt & Hummel, 2003). In this regard, mind and intelligence games can be considered as compatible with Piaget's constructivist approach, as they provide students with opportunities for active learning. Supporting learning through exploration, experimentation, and hands-on engagement, these games also contribute to cognitive development in line with Vygotsky's (1979) socio-cultural theory, which emphasizes the importance of social interaction and collaboration. Mind and intelligence games can serve as structured cognitive support tools, guiding students through problem-solving tasks and aligning with one of the central components of socio-cultural theory. These interactive activities stimulate various cognitive domains such as problem solving, critical thinking, memory, reasoning, and pattern recognition (Baniqued et al., 2014). Educators who incorporate these games into primary education contexts can create multiple opportunities for cognitive growth and enrichment, thereby supporting students in enhancing their learning experiences and academic performance. Moreover, by facilitating peer interaction, these games provide students with opportunities to develop critical thinking within a social context. At the same time, they encourage positive attitudes toward learning by offering enjoyable and engaging activities (Boot et al., 2011), while the elements of competition and cooperation inherent in the games foster group work (Green & Bavelier, 2012).

Mind and intelligence games may also provide educators with valuable insights into students' cognitive strengths and weaknesses, thereby informing timely interventions and the design of appropriate teaching strategies (Thompson et al., 2013). Understanding the effectiveness of these games in promoting cognitive skill development at the primary level requires consideration of various influencing factors. Research indicates that when mind and intelligence games are adapted to students' learning profiles, they can be highly effective. Moreno and Mayer (2007) highlight the importance of

instructional design principles and teaching strategies in maximizing the impact of such interventions, noting the interplay of teaching methods and environmental factors. By considering the complex interaction among individual differences, instructional methods, and contextual variables, more effective mind and intelligence game interventions can be designed and implemented in primary schools.

The Relationship Between Mind and Intelligence Games and Problem-Solving and Critical Thinking Skills

The development of higher-order thinking and problem-solving skills in children has emerged as a central objective of contemporary education systems. Recent research demonstrates that mind and intelligence games not only support cognitive processes but also foster higher-order thinking and metacognitive strategies. Specifically, modern board games, chess, strategy-based digital games, and puzzle games contribute to students' advancement in the upper domains of Bloom's taxonomy, including planning, analysis, synthesis, and evaluation (Anggoro et al., 2025; Vita-Barrull et al., 2023). In this context, the longitudinal study by Adachi and Willoughby (2013) on strategic video games highlights the link between gameplay and problem-solving skills, underscoring the long-term cognitive benefits of such activities. Likewise, Sala and Gobet (2016) suggest that board games such as chess yield substantial gains in multiple cognitive domains, including problem solving and critical thinking.

Mind and intelligence games enhance children's cognitive flexibility, equipping them with the ability to generate alternative solutions to complex problems and to engage in logical reasoning (Gundersen & Lampropoulos, 2025; Güneri & Korkmaz, 2023). Games such as Sudoku, chess, and Kakuro, in particular, encourage learners to employ advanced strategies including trial-and-error, hypothesis formulation, and the evaluation of solution pathways (Vita-Barrull et al., 2023). These games have also been shown to positively influence various cognitive domains, including cognitive flexibility, calculation and reading fluency (Vita-Barrull et al., 2023), memory (Miyake et al., 2000), and attention. Accumulating evidence indicates that mind and intelligence games exert a complementary effect on both problem-solving and critical thinking. National studies similarly reveal that these games promote notable improvements in diverse skills among primary school students, including creative writing, problem solving, socialization, critical thinking, decision-making, and attention (Ataç, 2025; Dal Çalışıcı, 2023; Kartal, 2023; Özen, 2023; Şişman, 2022; Zilan, 2023). Game-based learning environments appear to expand students' repertoire of solution strategies and critical reasoning abilities, illustrating that problem-solving and critical thinking operate as mutually reinforcing processes (Anggoro et al., 2025; Rezaei-Zadeh et al., 2023). Furthermore, the systematic integration of these games into educational settings not only supports students' academic and cognitive growth but also strengthens their critical and analytical thinking capacities in a comprehensive manner (Checa-Romero & Gimenez-Lozano, 2025).

Purpose of the Study

Sustainable success in education requires more than the transfer of knowledge; it depends on equipping students with higher-order cognitive and analytical competencies. Recent studies indicate that mind and intelligence games substantially contribute to children's cognitive development, particularly by strengthening their critical thinking and problem-solving skills. Supported by cognitive development theories, the literature emphasizes that learning environments enriched with such games activate higher-order mental processes in students. At the same time, constructivist and socio-cultural approaches highlight that these games enable students to actively construct knowledge and develop multiple solution strategies. Building on these perspectives, the present study is grounded in constructivist and socio-cultural theories, with the assumption that mind and intelligence games foster the cognitive development of primary school students by enhancing their critical thinking and problem-solving abilities. Furthermore, the Türkiye Yüzyılı Maarif Model, implemented nationwide in 2024, categorizes conceptual skills into basic, integrative, and higher-order thinking skills, and promotes their development through a holistic approach. Within this framework, critical thinking and problem-solving—emphasized as key higher-order competencies—are not only intended to facilitate access to

knowledge but also to cultivate individuals who can question, analyze, and generate solutions to real-life problems. Critical thinking encompasses competencies such as questioning information, events, or problems, reasoning through issues, and reflecting on conclusions. Problem-solving, on the other hand, involves processes such as identifying and structuring a problem, summarizing, making data-based predictions, generating solutions, and evaluating outcomes. The *Maarif Model* underscores that these two competencies should not be developed in isolation but as interrelated and mutually reinforcing processes (MoNE, 2024).

Accordingly, the primary aim of this study is to investigate the effects of mind and intelligence games on primary school students' critical thinking and problem-solving skills, as well as to explore students' perspectives on these games. The study evaluates the impact of implementing such games in classroom settings, taking into account individual differences, instructional methods, and contextual factors. The research sub-questions guiding this study are as follows:

1. When controlling for pre-test scores, is there a significant difference in post-test critical thinking scores between the experimental and control groups?
2. When controlling for pre-test scores, is there a significant difference in post-test problem-solving scores between the experimental and control groups?
3. What are the views of students in the experimental group regarding playing mind and intelligence games in the classroom?

Method

This study employed an explanatory sequential mixed-methods design, in which quantitative data are collected and analyzed first, followed by the collection and analysis of qualitative data. The purpose of this sequential structure is to provide a more comprehensive explanation of the quantitative results (Creswell, 2016). In line with this approach, quantitative data in the present study were initially obtained and analyzed using standardized scales, after which qualitative data were collected and interpreted to enrich and contextualize the findings. The overall research model and procedure are illustrated in Figure 1.

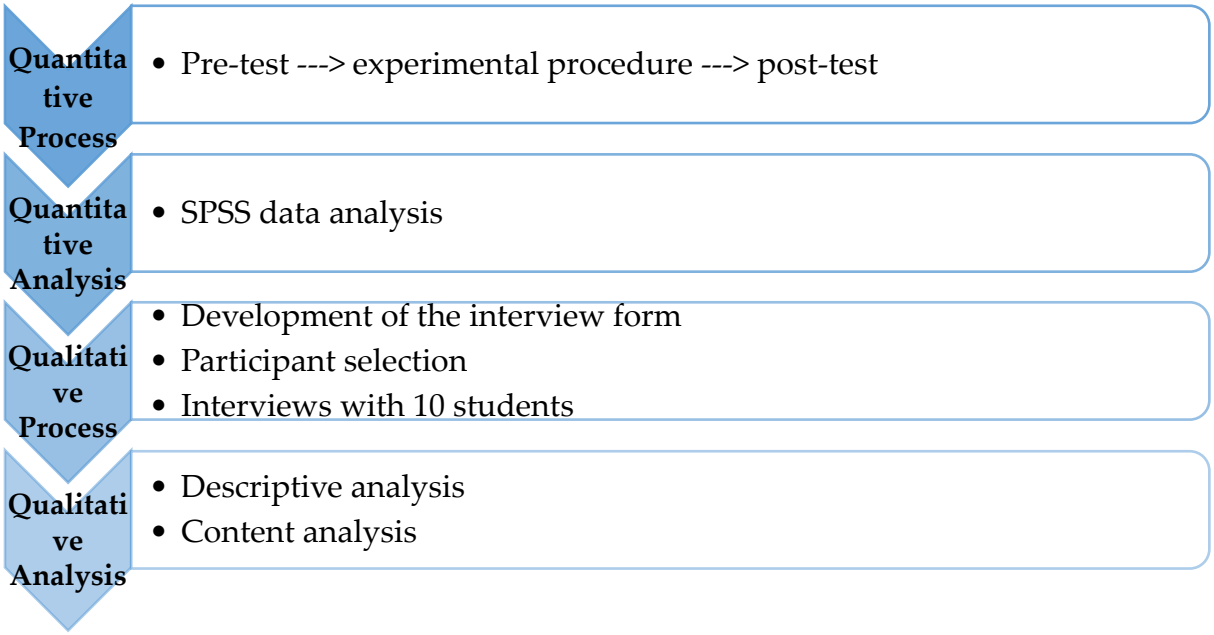

Figure 1. Research Model and Procedure

In this study, quantitative data were collected through an experimental procedure, and upon completion of this phase, qualitative data were subsequently obtained. This sequential design allowed for a deeper exploration of the experimental group's perceptions and experiences regarding the games implemented during the intervention

Study Group

The study was conducted with fourth-grade primary school students. Participation was voluntary, and the demographic characteristics of the students are presented in Table 1.

Table 1. Demographics of Participants

Variable	Sub-variable	Groups	
		Experimental (N)	Control (N)
Gender	Female	9	11
	Male	17	18
Preschool Education	Yes	13	22
	No	13	7
Mother's Education	Primary school	1	1
	Secondary school	8	8
	High school	15	16
	University	2	4
Father's Education	Primary school	3	-
	Secondary school	3	4
	High school	13	16
	University	7	9

As seen in Table 1, the students in the experimental and control groups demonstrated similar characteristics in terms of gender, parents' educational background, and preschool education experience.

Data Collection Tools

The data for this study were collected using four instruments. Permissions for their use were obtained, and detailed information is provided below.

1. Personal Information Form*:* This form included items related to students' demographic characteristics such as gender, preschool education background, and parental education levels.

2.Critical Thinking Skills Test*:* Developed by Eğmir and Ocak (2016), this test consists of 25 multiple-choice items. Participants are asked to read each item and select the option they consider most appropriate. Correct responses are scored as 4 points and incorrect responses as 0, yielding a total possible score between 0 and 100. An example item is as follows:

"Students should be allowed to eat and drink whenever they want at school." Which of the following would best express disagreement with this statement?

a. In this way, all students would feel freer.

b. Such arrangement would ensure that students are adequately nourished.

c. In this scenario, distractions would reduce students' attention during lessons.

d. As a result, students would be happier at school.

3. Problem-Solving Skills Scale*:* Developed by Sezgin (2011) to measure the problem-solving levels of 4th- to 8th-grade students, this scale consists of seven sections structured around a scenario. Students are expected to solve the problems by applying skills such as recognizing the existence of a problem, defining it, establishing cause–effect relationships, reviewing possible solutions, selecting the best option, implementing it, and representing the data with diagrams and figures. The scale yields scores between 0 and 88. The item difficulty index ranges from 0.37 to 0.81, while the item discrimination index ranges from 0.33 to 0.81. The KR-20 reliability coefficient of the scale is .76, and the test–retest coefficient is .94.

4. Semi-Structured Interview Form on Games: Prepared by the researchers, this form consists of five questions. The development process involved the following steps: (1) creating a pool of questions aligned with the research objectives, (2) reviewing their appropriateness for the language development of fourth-grade students and the research context, (3) obtaining expert opinions, (4) conducting a pilot study with two primary school students, and (5) revising the form for clarity and comprehensibility. An example item is:

> *Question 4: How did playing mind and intelligence games affect you? (Did playing such games benefit you?)*

Data Collection Process

This study was conducted during the fall semester of the 2023–2024 academic year in the city center of Kırıkkale. One of the researchers assumed the role of implementer**,** while the other two acted as observers and supporters**.** The implementer, who also held a certified trainer qualification in mind and intelligence games, met with teachers, administrators, and students at the school where the study was carried out, explained the purpose of the research, and administered the pre-test, post-test, and experimental procedures. The researchers serving as observers contributed by reviewing the literature, monitoring the implementation, conducting semi-structured interviews, and assisting in the analysis and reporting of the findings.

The school administration, classroom teacher, and parents were informed about the aims and procedures of the study, and it was clearly stated that participants could withdraw at any time without providing justification. The identities of the participating students were kept confidential, and pseudonyms were assigned to them. To conduct the study, ethical approval was obtained from the Social and Human Sciences Research Ethics Committee of Kırıkkale University, a public university in Türkiye, with the decision dated 18.11.2021 and numbered 11.

The quantitative phase of the study was conducted in accordance with a quasi-experimental design. Data collection spanned 14 weeks: one week for administering the pre-test, one week for the post-test, and 12 weeks for the intervention. Prior to the intervention, both experimental and control group students completed the *Personal Information Form, the Critical Thinking Skills Test, and the Problem-Solving Skills Scale* as pre-test measures.

Mind and intelligence games (board games) were implemented with students over a 12-week period. The games were first introduced and their rules explained, after which students played individually, in pairs, or in groups. The sessions were conducted in the classroom under the supervision of the researcher and the teacher, with regular reminders about the courtesy rules to be followed during gameplay. The games used in the intervention and the associated tasks are presented in Table 2. As the games also bear brand names, they were coded for research purposes.

Table 2. Quasi Experimental Procedure and Activities

Week	Games	Procedure
1. Week (80 min.) 2. Week (80 min.)	1_IBG: An individual game consisting of 60 task cards and five differently shaped brick-like pieces. The goal is to form the figure shown on the task card using these pieces.	Each student received a game set in a box. The materials and visuals were introduced and demonstrated, allowing students to examine them. After the rules were explained, students played the game individually.
3. Week (80 min.) 4. Week (80 min.)	2_K: Played by 2 or 4 players on a platform of 81 squares, the aim of the game is to move one's pawn to the first square of the opponent's area	The materials were introduced and the rules explained. Students were paired to play independently, with rules reinforced, clarifications provided, and questions answered during the game
5. Week (80 min.) 6. Week (80 min.)	3_RS: A puzzle with 60 tasks at varying levels. The goal is to arrange the differently colored and shaped pieces as indicated in the task book to move the red piece out of the platform without shifting the fixed white pieces.	The game was introduced, rules explained, and students were given time to examine it. Afterward, they played in pairs. During play, rules were reinforced, and students were encouraged to cooperate, ask questions, and make decisions.
7. Week (80 min.) 8. Week (80 min.)	4_K: This award-winning game is played with 48 task cards and six illustrated transparent pieces. The aim is to correctly place the transparent pieces according to the task card.	After the pieces and rules were introduced, students were paired to complete easier tasks together to become familiar with the game, and then they played individually.
9. Week (80 min.) 10. Week (80 min.)	5_R: Played by two players on an 8×8 board with 64 black-and-white stones, the aim is to finish the game with more stones of one's own color than the opponent.	After the rules were explained in detail, students were paired and each group received a game set to play. During the process, the researcher circulated in the classroom to provide guidance.
11. Week (80 min.) 12.Week (80 min.)	6_A: This game is played on a hexagonal board with 61 holes, using 14 white and 14 black marbles. The aim is to push six of the opponent's marbles off the board	The rules were explained and students' questions were answered. While playing in pairs, students were reminded of the rules when necessary

During each week of the intervention, students were reminded to follow communication rules, ask questions when they did not understand, listen to and observe their peers, and congratulate the winner. In the qualitative phase, following the completion of the quasi-experimental intervention, semi-structured interviews were conducted with 10 students randomly selected from volunteers in the experimental group. The "*Semi-Structured Interview Form on Games*" served as the data collection tool. Each interview was held individually in the school library, with the questions read aloud to the student. Interviews were audio-recorded, and students' verbal responses were simultaneously transcribed onto the interview form. Each session lasted approximately 15 minutes. In line with ethical principles, no personal information was recorded, and pseudonyms were assigned to participants. After each interview, the transcript was read aloud to the student for confirmation of accuracy.

Data Analysis

The responses provided by students to the data collection tools before and after the quasi-experimental procedure were listed, categorized, and entered into a computer-assisted statistical program. To control for pre-test score differences between the experimental and control groups, an Analysis of Covariance (ANCOVA) was conducted. The use of ANCOVA requires that certain assumptions be satisfied (Kilmen, 2020):

1. The groups must be independent of each other.
2. The dependent variable must be measured on at least an interval scale.
3. The population distributions from which the samples are drawn must be normal, and variances must be homogeneous.
4. For all groups, there must be a linear relationship between the dependent and covariate variables, and homogeneity of regression slopes must be established.

In this study, because the experimental and control groups were independent, and the dependent variables—problem-solving and critical thinking skills—were measured with the *Critical Thinking Skills Test* and the *Problem-Solving Skills Scale* (both validated and reliable interval-level instruments), the first two assumptions were satisfied. To test the third assumption, the Shapiro–Wilk test was used to examine whether the data followed a normal distribution. This test was chosen because it provides more reliable results when the sample size is below 50 (Büyüköztürk, 2007). The results of the Shapiro–Wilk test, together with skewness and kurtosis values, are presented in Table 3.

Table 3. Shapiro Wilk Test Results of Pre and Post Tests

Variable	Test	Experimental Group				Control Group			
		Z	P	Skew.	Kurt	Z	P	Skew.	Kurt
Critical Thinking	Pre-test	.961	.418	-.041	-.291	.929	.053	.663	.194
Skills	Post-test	.970	.621	.204	-.194	.966	.467	.324	-.119
Problem Solving	Pre-test	.979	.853	.238	-.113	.938	.089	-.341	-.956
Skills	Post-test	.988	.983	-.092	-.214	.952	.209	-.324	-.817

As shown in Table 3, the p-values for the critical thinking and problem-solving scores of students in both the experimental and control groups were not statistically significant. Skewness and kurtosis values ranged between –.956 and .663. These findings indicate that both the Shapiro-Wilk test results and the skewness and kurtosis values fall within the acceptable limits of normal distribution (George & Mallery, 2010; Tabachnick & Fidell, 2013). Therefore, the assumption of normal distribution required for ANCOVA was satisfied. The assumption of homogeneity of variances was tested using Levene's test, and the results are presented in Table 4.

Table 4. Levene test results for homogeneity of group variances

Variable	F	df1	df2	P
Critical Thinking Skills	.636	1	53	.429
Problem Solving Skills	.120	1	35	.720

According to Table 4, the p-values for both critical thinking and problem-solving scores were not statistically significant ($p > .05$). Thus, the assumption of homogeneity of variances for the measurements conducted in this study was met.

To test the assumption of "a linear relationship between the dependent and controlled variables for all groups, and homogeneity of regression slopes," scatter plots were examined, and linear relationships between the variables were observed. In addition, Pearson correlation analysis was conducted to determine the correlation coefficients between the pre-test and post-test scores of the applied scales, and the results are shown in Table 5.

Table 5. Pearson correlation coefficients between pre and post test scores for variables

Variable	Critical Thinking Skills Post-test	Problem Solving Skills Post-test
Critical Thinking Skills Pre-test	.789**	
Problem Solving Skills Pre-test		.548**

**<.01

According to Table 5, there was a significant and high correlation at the .01 level between the pre- and post-test scores of critical thinking skills, and a significant and moderate correlation at the .01 level between the pre- and post-test scores of problem-solving skills. These findings confirm that the assumption of a linear relationship between the pre-test and post-test scores of both variables was satisfied.

For the assumption of homogeneity of regression slopes, the interaction effect of Group × Pre-test scores on the post-test scores of critical thinking and problem-solving skills was examined using ANOVA. The results are presented in Table 6.

Table 6. ANOVA Results for the Homogeneity of Regression Slopes

Variable	Source of Variance	Sum of Squares	df	Mean Square	F	P
Critical Thinking Skills	GroupxPre-test	130.405	1	130.405	1.435	.233
Problem Solving Skills	GroupxPre- test	16.798	1	16.798	.224	.638

As shown in Table 6, the Group × Pre-test interaction effect on the post-test scores of critical thinking and problem-solving skills was not statistically significant ($p > .05$). This indicates that the assumption of homogeneity of regression slopes was met.

In the quantitative phase of the study, ANCOVA was applied to determine whether there were significant differences between the post-test scores of the experimental and control groups, since all assumptions were satisfied. Additionally, independent samples t-tests were used to examine whether there were differences in pre-test scores between the groups. Descriptive statistics were also employed to compare the demographic characteristics of the students in the study group.

In the qualitative phase, data obtained from the individual interviews conducted with students after the quasi-experimental procedure were analyzed through content analysis. Content analysis is a systematic and objective method that enables valid inferences to be drawn from verbal, visual, or written data in order to describe and measure specific phenomena (Bengtsson, 2016). This method allowed for an in-depth examination of the data and the identification of recurring themes and patterns. For Questions 1, 3, and 5, the frequency of words, expressions, and elements used by students was examined and numerically categorized according to frequency of occurrence (Bilgin, 2006). For Questions 2 and 4, the data were coded, categories were developed, and evaluations were conducted based on these categories. The stages of content analysis proposed by Kuckartz (2019) were followed:

1. The data were prepared for analysis: audio recordings were listened to, previewed, and transcribed into written documents.
2. Interview transcripts were independently reviewed by the researchers. Each researcher examined students' responses to every question, identified commonalities, and conducted coding and categorization.
3. The researchers compared and discussed their coding, themes, and categories until consensus was reached.
4. The coding and category list prepared by the researchers was reviewed by two additional researchers, and agreement was confirmed.
5. The findings were interpreted, evaluated, and reported.

To ensure validity and reliability, researcher triangulation was employed (Yıldırım & Şimşek, 2005). The data were examined by both the researchers and two external experts, and analyses were carried out based on themes and codes on which consensus had been achieved. In addition, direct quotations from student responses were included to accurately reflect their perspectives and experiences.

Findings

The findings are presented in this section in line with the research questions. To determine whether there were significant differences between the pre-test scores of the experimental and control groups in terms of critical thinking and problem-solving skills, an independent samples t-test was conducted. The results are shown in Table 7.

Table 7. T-Testi Results for Pre-Test Scores of Students in Experimental and Control Groups

Variable	Group	N	$\bar{X}$	S	df	t	P
Critical Thinking Skills	Experimental	26	30.08	7.28	53	-.394	.695
	Control	26	30.86	8.77			
Problem Solving Skills	Experimental	29	22.02	11.90	53	-.478	.634
	Control	29	23.38	10.23			

As seen in Table 7, the results of the pre-tests indicate that there were no significant differences between the experimental and control groups in terms of critical thinking and problem-solving skills. This finding suggests that the groups were equivalent before the intervention.

Findings Related to Critical Thinking Skills

The pre-test and post-test scores of students in the experimental and control groups on the critical thinking scale, along with the adjusted means calculated through ANCOVA, are presented in Table 8.

Table 8. Pre-Test, Post-Test, and Adjusted Post-Test Mean Scores of Experimental and Control Group Students' Critical Thinking Skills

Group	Test	N	Sum		Adjusted	
			$\bar{X}$	S	$\bar{X}$	SE
Experimental Group	Pre-test	26	30.08	7.28		
	Post-test	26	41.62	10.20	42.05	.759
Control Group	Pre-test	29	30.86	8.77		
	Post-test	29	33.48	7.20	33.09	.718

According to Table 8, the adjusted mean score for critical thinking was $\bar{X}$ =42.05 for the experimental group and $\bar{X}$ =33.09 for the control group. To determine whether the difference between the groups' adjusted post-test scores was significant, a covariance analysis was conducted. The results are shown in Table 9.

Table 9. Covariance Analysis Results of Critical Thinking Scores of Experimental and Control Group

Source of Variance	Sum of Squares	df	Mean Square	F	P	Partial η^2
Pre-test	3278.531	1	3278.531	219.451	.000	.808
Group	1099.649	1	1099.649	73.606	.000*	.586
Error	776.864	52	14.940			
Total	81595.000	55				

*<.05

According to the results presented in Table 9, when the pre-test score for critical thinking was controlled, there was a significant difference between the adjusted post-test mean scores of the groups ($F(1, 52) = 219.451$, $p < .05$). Furthermore, the partial eta-squared value ($\eta^2 = .586$) indicates a large effect size. These findings show that mind and intelligence games made a substantial contribution to the development of students' critical thinking skills.

Findings Related to Problem-Solving Skills

The pre-test and post-test scores of students in the experimental and control groups on the problem-solving scale, along with the adjusted means calculated through ANCOVA, are presented in Table 10.

Table 10. Adjusted Mean Pre-Test and Post-Test Scores for Problem-Solving Skills of Experimental and Control Group Students

Group	Test	N	Sum		Adjusted Pos-test	
			$\bar{X}$	S	$\bar{X}$	SE
Experimental Group	Pre-test	26	22.02	11.90	38.88	1.68
	Post-test	26	38.57	10.08		
Control Group	Pre-test	29	23.38	10.23	25.16	1.59
	Post-test	29	25.44	9.26		

As seen in Table 10, the adjusted mean score for problem solving was $\bar{X}$ =38.88 for the experimental group and $\bar{X}$ =25.16 for the control group. A covariance analysis was conducted to compare the adjusted post-test scores of students' problem-solving skills. The results are presented in Table 11.

Table 11. Covariance Analysis Results of Experimental and Control Group Students' Problem-Solving Skills Scores

Source of Variance	Sum of Squares	df	Mean Square	F	P	Partial η^2
Pre-test	1091.927	1	1091.927	14.749	.000	.221
Group	2567.705	1	2567.705	34.683	.000	.400
Error	3849.759	52	74.034			
Total	62392.323	55				

*<.05

According to Table 11, when the pre-test scores for problem-solving skills were controlled, there was a significant difference between the adjusted post-test mean scores of the groups ($F_{(1, 52)}$=14,749; p<,05). The partial eta-squared value ($\eta^2 = .400$) also indicates a large effect size. These findings suggest that mind and intelligence games significantly contributed to the improvement of students' problem-solving skills.

Findings Related to Students' Views on Mind and Intelligence Games

The third sub-problem of the study was formulated as follows: "What are the views of fourth-grade students in the experimental group regarding playing mind and intelligence games in class?" To address this question, individual interviews were conducted with 10 students (5 girls and 5 boys) from the experimental group after the intervention. During these interviews, students shared their opinions, suggestions, and feelings about the mind and intelligence games. The findings from the interviews are presented alongside supporting figures and tables. Figure 2 displays the games most frequently recalled by students following the 12-week intervention.

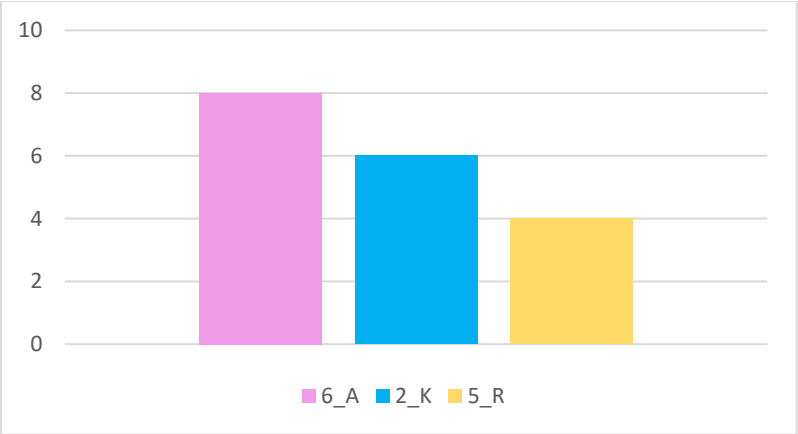

Figure 2. The Games Most Remembered by Students During the Experimental Procedure

The interviews indicated that the games most frequently recalled by students after the 12-week intervention were those coded as 6_A, 2_K, and 5_R. Examples of students' responses to the first question are provided below as direct quotations:

S1: *"Of course, I remember some of the games. I remember 6_A and 2_K the most."*

S2: *"Teacher, I mostly remember 2_K."*

S5: *"We played the 5_R game, I also remember 6_A, and there was another one, 5_R."*

S9: *"There was 6_A, and 2_K also stayed in my mind."*

Students were also asked how they felt about playing the games. All participants stated that they enjoyed playing mind and intelligence games in class and emphasized the various benefits they had gained. The codes and categories derived from their responses are presented in Table 12**.**

Table 12. Distribution of Responses Regarding the Benefits of Mind and Intelligence Games

Codes	Category	Students
Personal Growth	Cognitive development	S3
	Imagination	S4
	Learning	S5
Enjoyment-Appreciation	Enjoyable lessons	S6, S10
	Enjoying the game	S4, S5, S8
Lesson Contribution	Paying attention in lessons	S1
	Comprehension of the tasks	S2
	Enjoying the lesson	S6

According to Table 12, students reported that the games made the lessons more enjoyable and contributed to their personal development. Selected statements are provided below:

S1: *"I became more careful when solving problems in class."*

S2: *"I now understand Turkish better. I started to enjoy the lessons."*

S3: *"I think these games improved my intelligence."*

S4: *"Yes, I liked all these games. I both thought and imagined."*

S5: *"I liked playing games in class. It gave us something to do, and we also learned new things."*

S6: *"Yes, I liked it. With these games, math became more enjoyable."*

S7: *"I had a lot of fun while playing, and I also learned new things."*

Students were further asked which games they would like to play more frequently and for longer durations. Their responses are summarized in Figure 3.

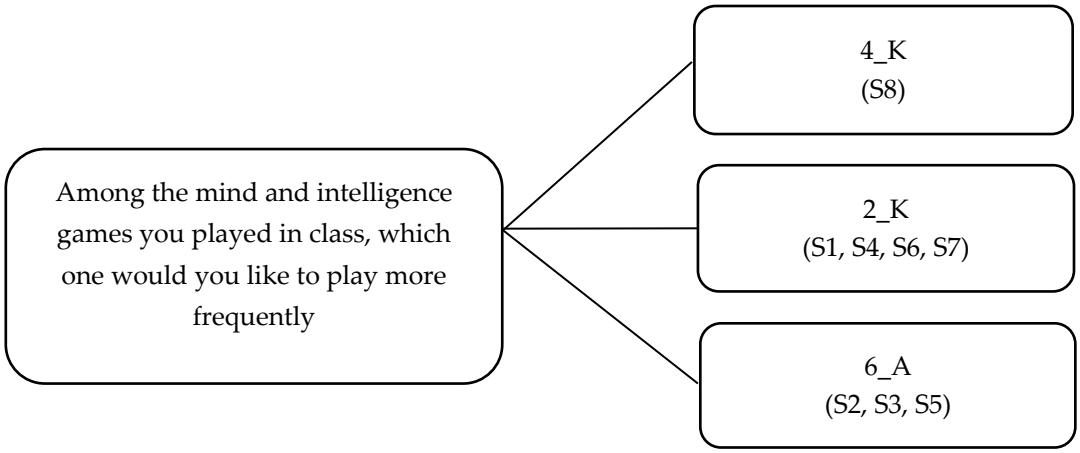

Figure 3. The Games Students Preferred to Play More

According to Figure 3, students most frequently mentioned *2_K* and *6_A* as the games they wished to continue playing. The fact that they could recall the names of the games and expressed a desire to engage with them more often after the intervention can be interpreted as evidence of the lasting impact these games had on students.

In addition, students shared their perspectives on the personal effects of the games. Their views regarding the benefits of playing mind and intelligence games are summarized in Table 13.

Table 13. Distribution of Responses Regarding the Benefits of Mind and Intelligence Games

Codes	Category	Students
Positive	Attention development	S1
	Success in mathematics	S6, S3
	Cognitive development	S4, S8, S10
	Academic success	S7, S5
Negative	No benefit	S2, S9

The majority of students reported that the games had a positive impact on them, particularly by enhancing their attention, supporting mathematics learning, and contributing to overall academic development. Illustrative student responses include:

S1: *"Before, I found reading or doing something difficult. When we played games in class, I was able to focus better."*

S3: *"I got better in lessons; I now listen to Turkish and math more carefully."*

S4: "Yes. It made me think. After the game ended, even after the lesson, I thought *about how else I could play it."*

S6: *"Math problems are easier for me now."*

S5: *"I think I imagine more now; I keep thinking about how to do things."*

Another interview question asked was: *"With which subject did you most associate the mind and intelligence games you played in class?"* The distribution of responses to this question is presented in Figure 4.

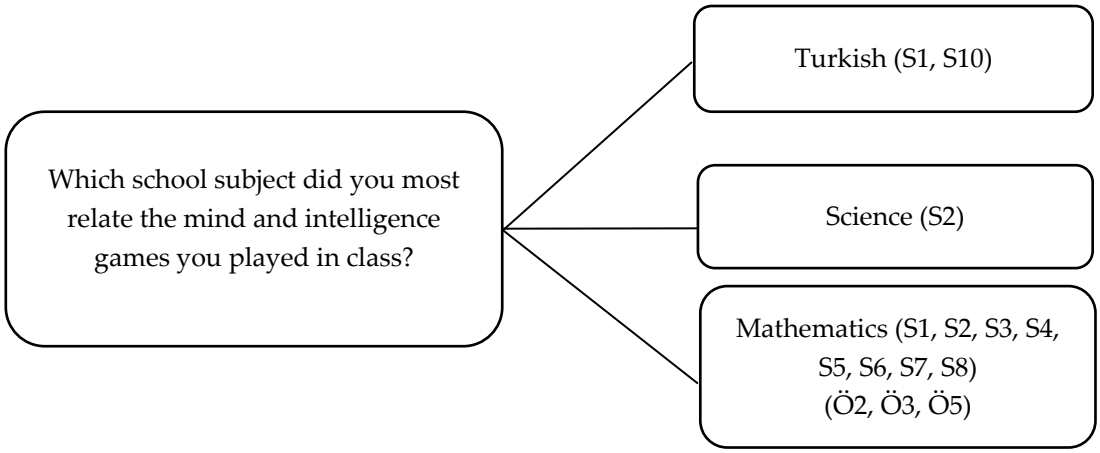

Figure 4. Distribution of Lessons Associated with the Games by Students

The interviews indicated that students most frequently associated the games with mathematics lessons. This tendency may be explained by the presence of elements such as grids, numbers, and point-based systems in several of the games. Furthermore, students were asked which of the games they would prefer to own and play at home. Their responses are illustrated in Figure 5**.**

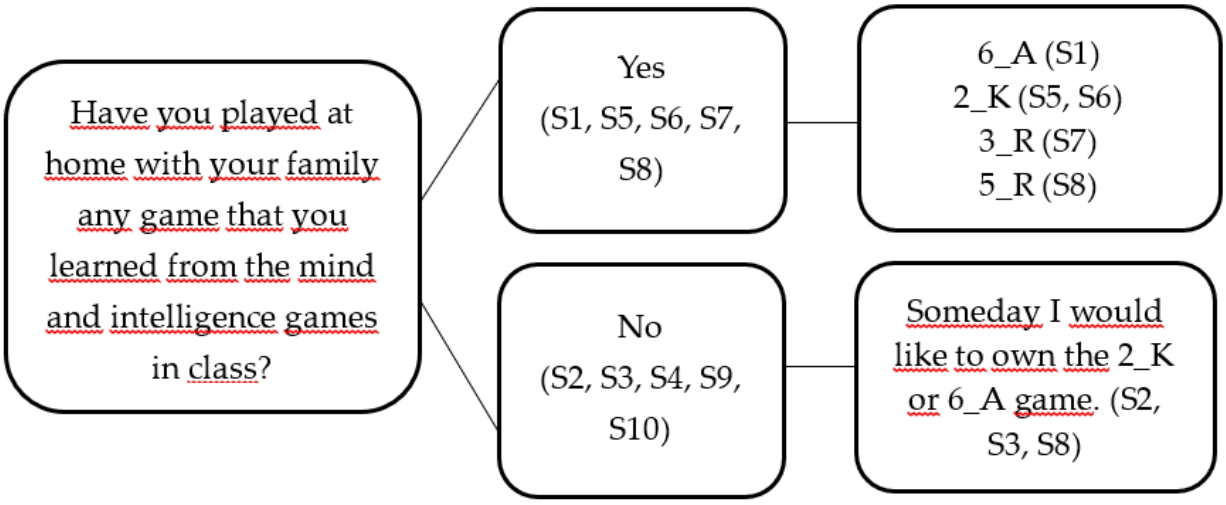

Figure 5. Distribution of the Games Preferred by Students to Play at Home

It was found that students most frequently expressed a desire to own and play the games coded as 6_A, 2_K, 3_R, and 5_R at home. Illustrative excerpts from their responses are provided below:

S5: *"I received the 2_K game as a birthday gift, and I really enjoy it."*

S3: *"I would really like to have 6_A at home. I liked it very much."*

Conclusion and Discussion

The purpose of this study was to investigate the effect of mind and intelligence games on the critical thinking and problem-solving skills of fourth-grade primary school students. This section presents the results and related discussion.

The experimental and control groups, which were equivalent in terms of gender, preschool education, and parents' educational background, were compared on their critical thinking and problem-solving skills through the experimental procedure. Pre-test results revealed no significant differences between the groups, indicating that they had similar characteristics prior to the intervention. Post-test results, however, showed that the experimental group scored significantly higher in critical thinking skills compared to the control group. Moreover, the eta-squared value indicated a large effect size,

suggesting that mind and intelligence games had a strong impact on the development of students' critical thinking.

These findings are consistent with previous research. For example, in an experimental study with identified gifted primary school students, Baş et al. (2020) reported that mind and intelligence games improved analytical thinking, critical thinking, and decision-making skills. Similarly, Dal Çalışıcı (2023) found that the critical thinking skills of third-grade students who received mind and intelligence games training developed significantly compared to those of the control group. Bartolucci et al. (2019) also observed that children who became proficient in selected board games were cognitively more active than their peers engaged in traditional educational activities. Their findings highlight that carefully chosen mind and intelligence games can stimulate cognitive functioning, particularly by fostering creativity, and thus play an important role in education. In contrast, Vural (2021), in a study with sixth- and seventh-grade students, reported no significant effect of mind and intelligence games on critical thinking skills. Seferoğlu and Akbıyık (2006) emphasized that fostering critical thinking requires learning environments where students can share and evaluate ideas, recognize diverse perspectives, and engage in activities that encourage reflection on their own thinking processes. In the present study, the classroom practices implemented during the mind and intelligence games supported these conditions: teamwork was emphasized, all students were included in each game, interaction was guided through teacher facilitation, and the principles of fair competition were reinforced. It can therefore be argued that both the collaborative classroom environment and the strategic moves required to succeed in the games contributed to the development of students' critical thinking. As Yeşilyurt (2021) highlights, the development of critical thinking—as a higher-order skill—is shaped by multiple factors, including family, culture, the richness of social and physical stimuli, socio-psychological conditions, heredity, and intelligence. Educational variables such as teaching practices, learning processes, teachers, and schools also play a significant role. In a similar vein, Oğuz and Aybek (2024) found that primary school students' critical thinking tendencies were influenced by their academic achievement and reading frequency. Within this context, deviating from the daily classroom routine to play games—particularly those that required questioning unfamiliar rules—appears to have activated key aspects of critical thinking such as generating alternative solutions and making evidence-based decisions. The attention and engagement generated during gameplay also supported students in developing personal strategies, analyzing problems, and evaluating opponents' moves. Furthermore, the competitive aspect of the games, where students attempted to outmaneuver opponents and score points, may have encouraged them to approach knowledge critically, question outcomes, and justify their reasoning—thus fostering essential components of critical thinking.

When pre-test scores were controlled, the analysis revealed a significant difference in the adjusted post-test means of the experimental and control groups in favor of the experimental group for problem-solving skills, with a large effect size. This indicates that mind and intelligence games had a strong positive impact on the development of students' problem-solving abilities. The improvement can be attributed to the structured, multi-step problem scenarios embedded in the games, which consistently allowed students to engage in analytical thinking, explore alternative strategies, and make decisions. For instance, the new obstacles encountered in each game required students to attempt alternatives quickly and develop new approaches in cases of failure. By experiencing processes such as problem structuring, summarizing, predicting, generating alternatives, and reflecting, students likely developed a more systematic approach to real-life problem solving. In particular, board games and strategy-based activities encouraged them to analyze problems, select appropriate solution paths, and apply them, thereby strengthening their problem-solving capacity. These findings suggest that engaging in natural and repeated problem-solving processes within game contexts can produce meaningful and lasting improvements in students' skills.

Problem solving is a core competency that supports individuals' cognitive development and enables them to generate effective solutions to everyday challenges. Previous research has consistently linked problem-solving skills with academic success, particularly in mathematics. For instance, Özsoy (2005) reported a strong positive correlation between problem-solving ability and mathematics achievement. Game-based learning approaches—especially board games—have been widely recognized as effective tools for enhancing problem-solving processes. Empirical evidence shows that board games positively influence children's mathematical thinking, creative problem solving, real-life problem-solving abilities, and reasoning skills. For example, science-based board games have been shown to foster creative problem solving by encouraging students to adopt multiple perspectives and generate alternative solutions (Chen, et al., 2021). Several experimental studies further support these findings. Demirel and Karakuş Yılmaz (2019) demonstrated that sixth-grade students who played mind games exhibited higher levels of problem-solving skills compared to their peers. Similarly, Assapun and Thummaphan (2023), using a game-based learning model with wooden block games, concluded that lower secondary students not only improved their problem-solving skills but also reported more positive learning experiences. In another study, Güneri and Korkmaz (2023) found that mind game activities enhanced both computational thinking and problem-solving skills among fifth graders while simultaneously increasing their enjoyment of lessons. Kurbal (2015) reported that intelligence games significantly improved sixth-grade middle school students' problem-solving strategies and reasoning skills. Similarly, in an experimental study with middle school students, Özen (2023) found that mind and intelligence games had a significant positive effect on students' problem-solving abilities. In another study, Şahin (2019) demonstrated that fourth-grade primary school students in the experimental group, who played intelligence games for eight weeks, showed significantly greater improvement in problem-solving skills compared to the control group. A study conducted with third-grade primary school students emphasized that playing games positively affected the memory development and numerical skills of the experimental group compared to the control group. In the same study, it was also observed that memory games contributed to the development of problem-solving skills among fourth-grade students. Researchers have therefore recommended the use of board games as an effective method for enhancing children's cognitive and mathematical development (Estrada-Plana et al., 2024; Kahraman, 2021). A recent meta-analysis on the use of games in mathematics education indicated that both traditional and modern games employed during the mathematics learning process are effective, improving students' proficiency and thereby enhancing the overall quality of mathematics learning in schools (Himmawan & Juandi, 2023). Furthermore, Wu and Su (2025), in their study with 74 third- and fourth-grade primary school students, found that while playing mind and intelligence games, students experienced the need to make choices and regulate these choices, which in turn fostered the development of their problem-solving thinking processes. Taken together, the findings of these studies align with those of the present research. It can therefore be concluded that mind and intelligence games exert positive effects on the development of a wide range of mathematics-related skills among primary and middle school students.

Consistent with quantitative results, qualitative data from student interviews also indicated favorable perceptions of the games. Specifically, the games most frequently remembered by students after the 12-week intervention were those coded as 6_A, 2_K, and 5_R, with many students expressing a desire to continue playing 2_K and 6_A more often. Overall, the interviews revealed that students valued the games, emphasizing their role in making lessons more enjoyable, stimulating imagination, supporting learning, and increasing motivation. Demirel and Karakuş Yılmaz (2016), in a study with secondary school students, reported that mind and intelligence games enhanced academic achievement, reinforced previously learned topics, facilitated new learning, promoted class participation, and made lessons more enjoyable. Similarly, teachers of mind and intelligence games in primary and secondary schools have emphasized their positive impact on interpersonal relationships and learner autonomy (Sadıkoğlu, 2017). The dual function of these games—being both educational and entertaining—suggests that their systematic integration into learning environments holds significant pedagogical value. Consistent with these findings, the majority of students in the present study reported that the

games improved their attention, mathematics performance, and overall academic development, thereby corroborating the quantitative results regarding enhanced problem-solving skills. Other studies have also reached parallel conclusions. Ayar (2022), for example, found that fourth-grade students experienced positive emotions while playing mind and intelligence games, valuing both the engaging designs and the sense of accomplishment they offered. Students described the games as enjoyable, educational, and stimulating, and even proposed that they should be institutionalized as a course. Likewise, Borçin Gökçe et al. (2023) demonstrated that mind and intelligence games significantly improved academic achievement among second-grade students.

In the qualitative strand of this study, most students associated the games with mathematics lessons, followed by Turkish and science. This aligns with Yöndemli and Taş (2018), who reported that mind and intelligence games positively influenced middle school students' mathematical reasoning skills. Teachers working in public schools also confirmed that these games strengthened students' attitudes toward mathematics, higher-order thinking skills, and academic performance (Kel & Kul, 2021). Classroom teachers further indicated that they frequently used these games, particularly in teaching geometric figures (Güneş & Yünkül, 2021). Beyond mathematics, mind and intelligence games have been shown to contribute to learning across various disciplines. For instance, Çağır and Oruç (2020) found that such games facilitated concept learning in the "Active Citizenship" strand of social studies for sixth-grade students and helped foster positive attitudes toward the subject.

Finally, several students in the present study expressed a desire to acquire and play some of the games at home, and a few had already done so. Considering the developmental characteristics of primary school students, the games' tangible, competitive, and visually appealing features likely encouraged students to sustain their interest and continue engaging with them beyond the classroom.

Limitations and Recommendations

This study is limited to the participation of 55 fourth-grade primary school students, six mind and intelligence games used as part of the intervention, a 12-week implementation period, and the data obtained through the instruments employed. Based on the findings, the following recommendations are proposed:

- Integrating mind and intelligence games into primary school curricula at selected stages may support the development of students' critical thinking and problem-solving skills while also enhancing the enjoyment of the learning process.
- Further original research is needed to explore the role of mind and intelligence games in shaping primary school students' learning dispositions.
- Experimental studies could be designed to examine the effects of such games on the development of collaboration, responsibility, and decision-making skills.
- Research and project-based inquiries may investigate the factors that influence the growth of critical thinking skills in students.
- Future studies might focus on the cognitive and affective factors that contribute to the improvement of problem-solving skills in primary school children.
- The impact of games on different domains of development can be examined by taking into account individual learner differences.

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