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Mind And Intelligence Games in Algorithm Teaching: Effects on Secondary School Students

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This study investigated the impact of using mind and intelligence games in algorithm teaching on 6th graders' computational thinking skills and programming self-efficacy. The research was carried out with 106 students in a public middle school in Kırıkkale during the 2022–2023 academic year, using a quasi-experimental design with experimental and control groups. The experimental group received two hours of mind and intelligence games per week for five weeks alongside the regular ITS course, while the control group followed the standard curriculum. A sequential explanatory mixed-methods design was used. Quantitative data were analyzed with t-tests, ANOVA, and Pearson Correlation, and qualitative data were obtained through interviews with 12 students. Results showed significant improvements in the experimental group's computational thinking and programming self-efficacy scores, whereas no significant change was observed in the control group. Post-test comparisons also favored the experimental group. A positive correlation was found between programming self-efficacy and computational thinking. Interview findings indicated that mind and intelligence games enhanced students' concentration, reasoning, decision-making, and logical thinking. Overall, the study suggests that incorporating such games into algorithm teaching supports cognitive development and strengthens programming skills.

Introduction

In the rapidly evolving, changing, and globalizing world, human knowledge and skills have undergone a significant transformation. Twenty-first century skills encompass information, media, and technology literacy; learning and innovation skills; creativity; design thinking; algorithmic thinking; collaboration; and social and intercultural competencies (Battelle for Kids, 2019). To cultivate individuals equipped with these skills, various reforms and innovations have been implemented both globally and in Turkey. Examples include the integration of new courses into curricula, the introduction of STEAM-based activities, and the expansion of extracurricular initiatives such as robotics applications. Recently, game-based

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learning has emerged as a particularly effective approach to fostering twenty-first century skills (MoNE, 2023; TÜBİTAK, 2024).

Educational games, aligned with the constructivist teaching principles adopted by the Ministry of National Education (MoNE), aim to enhance students' language, communication, social interaction, learning, and comprehension skills. Previous studies have demonstrated that mind and intelligence games can foster students' problem-solving, logical reasoning, and creative thinking abilities (Günüç, Odabaşı & Kuzu, 2013; Korkmaz, Çakır & Özden, 2015). In today's digital era, computational thinking skills and programming competencies have become essential in all areas of life. These skills not only strengthen problem-solving and logical reasoning abilities but also help individuals adapt to rapid technological advancements, thereby providing a competitive advantage (Akçay, Karahan & Türk, 2019; Temel & Mumcu, 2024). Algorithm teaching serves as a cornerstone for developing computational thinking and programming skills (Wing, 2006; MoNE, 2018). Nevertheless, teaching algorithms often presents challenges, such as students' difficulty in comprehending abstract concepts and applying problem-solving strategies effectively. To address these challenges, various instructional strategies, including game-based learning approaches, have been proposed (Tepgeç, 2017).

Recent studies have shown that mind and intelligence games help students develop logical reasoning, step-by-step thinking, and problem-solving abilities, while also making the learning process more engaging and motivating (Çağan, 2022; Marangoz & Demirtaş, 2017). However, research examining the impact of such games specifically on computational thinking skills and programming self-efficacy in the context of algorithm teaching remains limited (Adalıyılmaz, 2022). In other words, recent reviews underline a notable gap in research on game-based learning's impact on computational thinking and programming self-efficacy (Gasaymeh & AlMohtadi, 2024; Ma, 2023; Wang, Cheng & Li, 2023). These authors point out that, despite growing interest, few empirical studies assess how structured game interventions affect specific computational thinking skills or students' confidence in programming. Therefore, the present study aims to investigate the effect of using mind and intelligence games in algorithm teaching secondary school students' computational thinking skills and programming self-efficacy. This research aligns with a broader trend of development of innovative instructional strategies in computer science education (Kalelioğlu, 2015; Korkmaz, Çakır & Özden, 2017), and its findings are expected to contribute by demonstrating the effectiveness of game-based learning approaches.

Purpose of the Study

The purpose of this study is to examine the impact of using mind and intelligence games in algorithm teaching on sixth-grade students' computational thinking skills and programming self-efficacy. Employing a pre- and post-test design, the research aims to evaluate the effectiveness of this intervention on student performance. Within this framework, the main research question of the study is as follows: *What is the effect of using mind and intelligence games in algorithm teaching on sixth-grade students' computational thinking skills and programming self-efficacy?* The sub-research questions are formulated as follows:

1. Do mind and intelligence games used in algorithm teaching have an effect on sixth-grade students' computational thinking skills?

2. Do mind and intelligence games used in algorithm teaching have an effect on sixth-grade students' programming self-efficacy levels?
3. What is the relationship between sixth-grade students' computational thinking skills and programming self-efficacy levels when mind and intelligence games are used in algorithm teaching?

Method

Research *Model*

The study employed sequential explanatory design, a type of mixed methods research. It offers six basic designs for mixed methods researchers: three are concurrent and three are sequential. In this design, quantitative data are collected and analyzed first, followed by qualitative data (Figure 1). This approach generally prioritizes quantitative data, and qualitative data are typically obtained to supplement or enrich the quantitative data. Data analysis is often interconnected and frequently combined into data interpretation and discussion sections. This design is particularly useful for explaining unexpected research findings or relationships (Creswell, 2003).

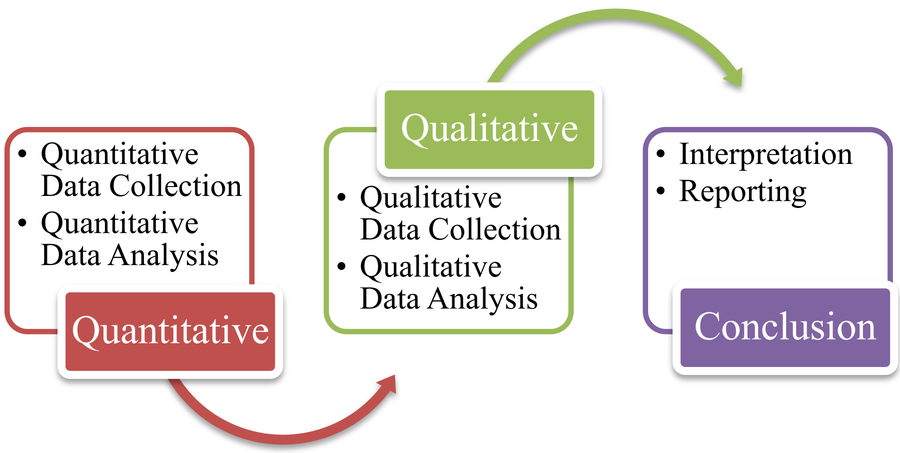

Figure 1. Research process model

Table 1 lists each stage of the research process in detail. This table clearly indicates which variables were measured by the different groups and which experimental methods were applied. In the pretest and posttest stages, the "Computational Thinking Scale (CTS)" and the "Programming Self-Efficacy Scale (PSS)" were administered to both groups. The students in the experimental group were exposed to mind and intelligence games for two hours a week for five weeks after the Information Technologies and Software (ITS) course. The students in the control group continued to take the ITS course in line with the normal curriculum. The specified scales and achievement tests were administered to both groups as pretests and posttests. At the end of the process in experimental group, qualitative data were collected and analyzed using a semi-structured interview form.

Table 1. Research Process

Stage	Group	Variable	Experimental Process
Pre-test	Experimental &Control	CTS, PSS	Questionaires were obtained.
Experimental Intervention	Experimental		Algorithm instruction through mind and intelligence games was implemented in ITS course.
	Control		Regular ITS course was conducted.
Post-test	Experimental &Control	CTS, PSS	Final measurements were obtained.
Qualitative Data Collection	Experimental	Semi-Structured Interview Form	Interview Analysis

Sample

The study group for this study consisted of sixth-grade students at a public middle school located in the central district of Kırıkkale, Türkiye. Sixth-grade students enrolled at this school during the 2022-2023 academic year constituted the main participant group for the study. Sixth-grade students were selected because, according to Piaget's theory of cognitive development, they are generally in the concrete operational stage. The study group consisted of students from diverse socioeconomic and cultural backgrounds and was selected on a voluntary basis. Throughout the research process, ethical principles were considered in collaboration with the students and their parents, and the necessary approvals were obtained. Thus, the validity and reliability of the study were ensured. Experimental and control groups were created by considering class sizes, gender parity, and academic achievement in the previous academic year. A study group of four classes was selected, with two classes serving as the experimental group and two as the control group.

Table 2. Distribution of Student Groups by Gender

		Grup				
		Experimental Group		**Control Group**		**Total**
		n	**%**	**n**	**%**	
Gender	Female	26	44,82	24	50	50
	Male	32	55,18	24	50	56
Total		58	100	48	100	106

Table 2 presents the distribution of demographic data by gender. The experimental group included 26 female and 32 male participants, while the control group included 24 female and 24 male participants, respectively. In total, both groups included 106 participants. The experimental group included 58 participants, while the control group included 48. A total of 106 participants were included in both test periods.

Research Process

In the study, a selection of games appropriate for the age groups of students determined by the researchers was created. During the selection process, feedback was obtained from experts who have worked in this field, academic, and a provincial coordinator of mind and intelligence games via email and face-to-face interviews. The implementation focused on the learning outcomes within the topical algorithm, which precedes the Block-Based Programming topic. Initially planned for seven weeks, the game activities were shortened to five weeks based on the feedback received and the weekly learning outcomes, the Information Technologies and Software (ITS) textbook, the ITS student materials book, and the ITS course presentations. Mind and intelligence games appropriate for the weekly activities in the ITS course curriculum were selected.

Before starting the implementation, the Computational Thinking and Programming Self-Efficacy Scale was administered to the students to collect initial data. At the end of the study, the same scales were re-administered to the students, and pre-test and post-test data were collected. Semi-structured interviews were also conducted with 12 students from the experimental group. The experimental group, after completing the weekly ITS course curriculum, underwent the implementation process and received regular training on mind and intelligence games from the course teachers throughout this process. The implementation was scheduled for two hours per week for five weeks. Before beginning the game activities, students in the experimental group were briefed on the rules and mechanics of the games, and then they practiced the game activities. At the end of each lesson, students were informed about the game to be played the following week. In the control group, the regular lesson flow continued in line with the ITS course curriculum. Pretests and posttests were administered simultaneously with the experimental group.

The games carefully selected for this study from the game pool were selected from among the board games available. These board games were intended to teach students about algorithms, and board games were chosen to attract students' attention. Students in the experimental group played the games identified in accordance with the weekly objectives in Table 3, regularly each week, after completing the ITS course.

Table 3. Learning Outcomes in ITS Coures related to Games used

Learning Outcomes in ITS Coures	**Games**
Discusses the relationship between mathematics and computer science.	Mangala
Uses constants and variables in problem solving.	Reversi
Divides a problem into sub-problems.	Equilibrio
Develops an algorithm to solve the problem.	Trafik (Rush hour)
Examines different algorithms and selects the fastest and most accurate solution.	Koridor (Coridor)

Note. These mind and intelligence games were used in the experimental group to teach algorithm concepts in the ITS course. Detailed information is provided in the Appendix.

Data Collection Tools

During the study, students were provided with the necessary explanations and guidance to ensure they completed the measurement tool completely and accurately. All data collected during the research process was entered into a digital environment and made suitable for analysis. Data was collected using two different measurement tools. Before analyzing the pre-test and post-test scores of the Computational Thinking Scale (CTS) and Programming Self-Efficacy Scale (PSS) of the students in the experimental and control groups, the data were examined to determine whether they met the requirements for parametric testing. The quantitative data collection tools used in the study, based on the research questions, are listed in Table 4. The scales used are listed in the table, respectively.

Tablo 4. Data Collection Tools

Number of Statements	Tools
19	Computational Thinking Scale (CTS)
31	Programming Self-Efficacy Scale (PSS)

Computational Thinking Scale (CCTS)

Developed by Karalar and Alpaslan (2021) for middle school students, the scale has a total of 19 items. The items are coded as "Totally Disagree," "Disagree," "Partially Agree," "Agree," and "Totally Agree." Data were coded so that "Totally Disagree," representing the most negative degree of computational thinking, was coded as 1, and "Totally Agree," representing the most positive degree of computational thinking, was coded as 5. This one-dimensional scale has no reverse items. The Cronbach's Alpha reliability coefficient for the scale is 0.95.

Programming Self-Efficacy Scale (PSS)

Developed by Kukul, Gökçearslan, and Günbatar (2017) for middle school students, the scale has a total of 31 items. The items are coded as "Strongly Disagree," "Disagree," "Undecided," "Agree," and "Strongly Agree." Data were coded so that "Strongly Disagree," representing the most negative programming self-efficacy rating, was 1, and "Strongly Agree," representing the most positive programming self-efficacy rating, was 5. This one-dimensional scale has no reverse items. The Cronbach's Alpha reliability coefficient for the scale is 0.95.

Tablo 5. Internal validity coefficients of the scales (reliability analysis)

	Pre Test		Post Test	
	Items	Cronbach Alpha	Items	Cronbach Alpha
Computational Thinking Skills Scale (CTS)	19	0,862	19	0,866
Programming Self-Efficacy Scale (PSS)	31	0,909	31	0,897

According to the internal validity coefficients in Table 5 in this study, internal validity coefficients of 0.862 and 0.866 were obtained for the CTS in the pretest and posttest periods, respectively. Similarly, internal validity coefficients of 0.909 and 0.897 were calculated for the PSS in the pretest and posttest periods, respectively. High internal validity coefficients were obtained for both measurement tools, indicating that the scales provide reliable and consistent measurements.

Qualitative Interview

A qualitative interview form, developed by the researcher, was used to determine students' perceptions of mind and intelligence games and their opinions regarding the application. A researcher, who has experience in this field, also added probe questions to elicit more detailed responses. This form was validated by consulting an academic expert in the field.

The form, which included five main questions, was administered to the 12 students from the experimental group. To ensure a representative sample for the interviews, students were selected from three distinct performance groups: high, medium, and low. These groups were determined by analyzing the gain scores (the difference between pre- and post-test scores) on the computational thinking and programming self-efficacy scales.

Data Analysis

Analysis of Quantitative Data

During the data collection process, data obtained using scales and achievement tests with validated and reliable values were transferred to digital media. During the data organization phase, negative items were corrected and coded to facilitate mean calculations. For example, the student who responded, "strongly agree" to the most negative item was coded "1," while the student who responded, "strongly disagree" to the most negative answer was coded "5." The corrected data were examined for missing or incorrect data. No missing or incorrect forms were observed.

A normality test was conducted to use parametric tests in the analysis of quantitative data. The statistics for the dependent and independent variables in the normality test are presented in Table 6. Different assumptions are required for using parametric tests. The specified skewness and kurtosis values were examined based on comments in the literature.

Tablo 6. Normal Distribution Values of Data Obtained by Data Collection Tools

Variable	N	Mean ($\bar{X}$)	SD	Skewness	Kurtosis
CTS	106	3,2552	0,058	-0,440	-0,065
PSS	106	3,2465	0,059	-0,528	0,298

When the values presented in Table 6 were examined, it was concluded that the kurtosis and skewness score distribution values met the specified parametric test conditions. According to the data, all kurtosis and skewness values were between the stated values of +1.0 and -1.0. Since the conditions for using parametric tests were met, parametric tests were used in the analysis of quantitative data. Pearson correlation was used to calculate the relationship between computational thinking skills and programming self-efficacy levels of 6th-grade middle school students.

Analysis of Qualitative Data

Qualitative analysis aims to identify relationships that can explain the data set and to reach common and systematic conclusions about the content. Content analysis is the process of organizing and interpreting data within the framework of similar concepts. In other words, the fundamental process is to gather and organize similar data within specific concepts and categories (Yıldırım & Şimşek, 2008). In the qualitative part of the study, students' views on mind and intelligence games were obtained using a semi-structured interview method. Content analysis and descriptive analysis were used together to analyze the obtained data. The data collected through the interviews were coded based on the questions asked during the interviews.

During coding, an attempt was made to divide the answers into sections that would form a meaningful whole, and data with similar meanings were labeled with the same codes. This attempt was made to obtain generalized statements. To reduce bias in the coding process and increase the consistency of the analyses, the data obtained from the interviews were analyzed by two independent coders.

Findings

This section presents the findings obtained from the statistical analysis of the data collected for the problems examined within the scope of the research.

Findings Related to Quantitative Data

Tablo 7. Processing experimental and control group students' T-test findings between pre-test and post-test scores on the CTS and PSS scales

Group	Scale	Test	N	Mean	Sd	t	p
Experimental	CTS	Pre-test	58	3,3620	0,59	-3,496	,001
		Post-test	58	3,6533	0,52		
Control		Pre-test	48	3,1261	0,56	-1,857	0,069
		Post-test	48	3,3059	0,66		
Experimental	PSS	Pre-test	58	3,3265	0,62	-3,922	0,0002
		Post-test	58	3,7180	0,53		
Control		Pre-test	48	3,1499	0,56	-1,961	0,055
		Post-test	48	3,3011	0,49		

According to the results of the study, students in the experimental group who participated in cognitive and intelligence games showed significant improvement in both Computational Thinking (CT) and Programming Self-Efficacy (PS).

In Computational Thinking Skills (CTS), the experimental group recorded a statistically significant increase (p=0.001) from the pre-test (Mean $\bar{X}$=3.36) to the post-test (Mean $\bar{X}$=3.65). Similarly, in Programming Self-Efficacy (PS), a significant difference (p=0.0002) was found between the pre-test (Mean $\bar{X}$=3.33) and post-test (Mean $\bar{X}$=3.72) averages of the experimental group.

Tablo 8. Effectiveness of the final test group on CTS and PSS according to groups T-test findings

Group	Scale	N	Mean	Sd	t	p
Experimental	CTS	58	3,6534	0,52317	-3,006	0,003
Control		48	3,3059	0,66667		
Experimental	PSS	58	3,7180	0,53426	4,024	0,001
Control		48	3,3011	0,52714		

The impact of the mind and intelligence games applications was analyzed by comparing the post-test scores of the experimental and control groups. For the CTS, the experimental group's mean score ($\bar{X}$=3.6534) was significantly higher than the control group's mean score ($\bar{X}$=3.3059) (p=0.003). For the PSS, similarly, the experimental group's mean score ($\bar{X}$=3.7180) was significantly higher compared to the control group's mean score ($\bar{X}$=3.3011) (p=0.001). Since the p-values for both scales are less than 0.05, there is a statistically significant difference in favor of the experimental group on both post-test measures.

Table 9. Findings on the relationship (correlation) between scales based on pre-test and post-test average data

Scales		(1)	(2)
Computational Thinking Scale (CTS) Pre-Test–Post-Test Means (1)	Pearson Correlation	1	0,606**
	Sig. (2-tailed)		<,001
	N	106	
Programming Self-Efficacy Scale (PSS) Pre-Test–Post-Test Means (2)	Pearson Correlation	0,606**	1
	Sig. (2-tailed)	<,001	
	N	106	106

A correlation analysis revealed a significant and positive relationship between students' scores on the Computational Thinking Skills (CTS) scale and the Programming Self-Efficacy (PSS) scale ($r=0.606$, $p<0.001$).

The $r=0.606$ value indicates a moderate positive relationship between the two variables, according to Cohen (1988). This result suggests that as a student's computational thinking skills increase, their level of programming self-efficacy tends to increase as well.

Findings Related to Qualitative Data

The qualitative data of the study were collected using a semi-structured interview technique conducted with 12 students randomly selected from the experimental group to explain the results obtained from the quantitative data. The qualitative dataset consisted of five main open-ended questions regarding the mind and intelligence games used during the lessons and the learning process. The students' responses to the questions were analyzed in detail, and codes and categories were created for each question.

Findings Related to Question 1

The students' opinions on the use of mind and intelligence game activities in the lessons were presented under the first questions: *"What do you think about the progression of mind and intelligence game activities during the lessons?"*, *"Do you think it was beneficial during the lessons? Could you elaborate a bit?"*, and *"What kind of benefits did mind, and intelligence games provide for you in the lessons?"*.

Table 9. Findings Related to Question 1

Questions	**Category**	**Code**	**f**	**Participants**
Q1. How would you evaluate the progression of the mind and intelligence games activities within the course?	In-class progression	Positive	12	STU1-STU12
		Negative	0	-

Q1a. Do you think these activities were beneficial during the course? Could you elaborate?	Perceived in-class benefit	Positive	12	STU1-STU12
		Negative	0	-
	Contributions within the lesson	Increased interest	4	STU3, STU4, STU5, STU10
		Cognitive development	5	STU2, STU6, STU8, STU9, STU12
		Cognitive development	2	STU1, STU7
Q1b. What benefits did the mind and intelligence games provide you during the lessons?	Acquired skills	Focus/concentration	1	STU2
		Logical reasoning	5	STU1, STU4, STU5, STU6, STU11
		Quick thinking	6	STU4, STU5, STU7, STU8, STU10, STU12
		Socialization	1	STU3

The study investigated the effects of mind and intelligence games on the teaching process by asking students the following question as part of the first inquiry: "What do you think about the progression of mind and intelligence games activities during the lessons?" All students stated that the progression of these games within the lessons was positive. Direct quotes from the students' responses are presented below:

STU9: "Our lesson progressed very well. Knowing which game we would play each week increased my interest in the lesson."

STU3: "It was good. I think it was very beneficial."

Subsequently, students were asked, "Do you think it was beneficial during the lessons? Could you elaborate?" All students responded positively. Additionally, four students mentioned that mind and intelligence games increased their interest in the lessons. Examples of their responses include:

STU4: "Yes, I think so. Playing games during the lesson increased my interest in the class."

STU10: "Yes, it was very useful during the lesson and increased my interest in the subject."

Furthermore, five students stated that these games could contribute to cognitive development. Examples of their responses are as follows:

STU2: "I think it was beneficial. It helped me use my mind more efficiently."

STU9: "Yes, I think it was beneficial. For instance, in the game of Mangala, we constantly followed the game and made moves based on the opponent's actions. We developed strategies."

In addition to these findings, two students mentioned that they spent quality time through mind and intelligence games activities. Relevant quotes include:

STU1: "Yes, I think it was beneficial. Playing mind and intelligence games added a lot to me. I had a great time with my friends."

Finally, students were asked, "What benefits did mind and intelligence games provide you during the lessons?" The skills gained by the students were identified as follows:

One student stated that they were able to focus better.

Five students mentioned that the games positively impacted their reasoning skills. For example:

STU6: "I can say that it helped me develop skills like logical and sequential thinking."

STU11: "It helped me think from a broader perspective."

Additionally, one student noted that the activities provided an opportunity for socialization, while six students stated that these activities improved their quick thinking skills. Examples include:

STU8: "It helped me gain attention, act faster, and think more quickly."

STU10: "It helped me think quickly and perform mental calculations easily."

In conclusion, the findings indicate that mind and intelligence games increased students' interest in lessons, contributed to cognitive development, enhanced reasoning and quick thinking skills, and provided opportunities for socialization and quality time.

Findings Related to Question 2

During the study, students were asked for their opinions regarding the repetition of mind and intelligence games activities and potential innovations. The following questions were posed: "Would you like mind and intelligence games activities to be conducted in the following years?" and "Would you like any changes to be made to the games?" Additionally, during the interview, the question "Why do you want changes to be made to the games?" was also asked.

Table 10. The codes and categories related to Question 2

Questions	**Category**	**Code**	**f**	**Participants**
Q2. Would you like the mind and intelligence games activities to be conducted in subsequent years?	Sustainability of Activities	Positive	12	STU1- STU12
		Negative	0	-
Q2a. Would you like changes to be made to the games?	Inclusion of Different Games	Yes	8	STU1, STU2, STU3, STU4, STU5, STU7, STU9, STU10
		No	4	STU6, STU8, STU11, STU12
		Playing group games	2	STU9, STU10

Q2b. Why do you want changes to be made to the games?	Rationale for Proposed Modifications	Getting bored of the same games	2	STU2, STU7
		Learning new games	3	STU1, STU4, STU5
		Games suitable for everyone	1	STU3

All students (n=12) responded positively to the question, "Would you like mind and intelligence games activities to be conducted in the following years?" Additionally, in response to the question, "Would you like any changes to be made to the games?" eight students stated that changes could be made to the games, while four students indicated that no changes were necessary.

During the interview, the follow-up question, "Why do you want changes to be made to the games?" was asked. Two students suggested that games suitable for group play could be selected. Their responses are as follows:

STU9: "Games that are played as group activities rather than individual ones could be chosen."

STU10: "Instead of individual games, group games could be an option."

On the other hand, two students mentioned that changes to the games would prevent them from becoming bored. Relevant quotes include:

STU2: "After a certain period, we start to get bored with the games."

STU7: "Playing the same game all the time can be boring."

Additionally, one student suggested that games suitable for everyone could be selected, while three students expressed that changes could be made to learn different games. Examples of their responses are as follows:

STU1: "I would like to play new games to learn different ones."

Findings Related to Question 3

When the students' responses to the question, "Do you think mind and intelligence games activities would have an impact on programming skills?" were analysed, specific codes and categories related to this question were identified.

Table 11. The codes and categories related to Question 3

Questions	Category	Code	f	Participants
Q3. Do you think the mind and intelligence games activities will have an effect on programming skills?	Impact on Programming Skills	Present	11	STU1, STU3, STU4, STU5, STU6, STU7, STU8, STU9, STU10, STU11, STU12
		Absent	1	STU2

Upon examining the table, it is evident that the majority of students stated that mind and intelligence games would have a positive impact on programming skills. Examples of student responses include:

STU6: "I think so. Because there are many games that can improve programming skills."

STU10: "Yes, I think it could have an impact. They were all like codes anyway."

However, one student expressed that playing mind and intelligence games would not have a positive effect on programming skills. The relevant response is as follows:

STU2: "I had never thought about it from this perspective, but I don’t think it would have an impact."

Findings Related to Question 4

In this section of the study, the questions *"What changes have occurred in your* perspective *toward mind and intelligence games after participating in these activities?"* and *"What positive perspectives have the mind and intelligence games activities developed in you?"* were asked to determine students' views on these games and the effects of playing them.

Table 12. The codes and categories related to Question 4

Questions	Category	Code	f	Participants
Q4. What changes occurred in your perspective toward mind and intelligence games after the activities?	Perspective on Mind and Intelligence Games	Positive	9	STU4, STU5, STU6, STU7, STU8, STU9, STU10, STU11, STU12
		Increased interest	3	STU1, STU2, STU3
Q4a. What positive perspective did the mind and intelligence games activities foster in you?	Effects on Perspective	Increased concentration	3	STU4, STU5, STU7
		Reasoning	6	STU6, STU8, STU9, STU10, STU11, STU12
		Rapid decision-making	1	STU2
		Logical thinking	2	STU2, STU3

In this section of the study, students were first asked about the changes in their perspectives toward mind and intelligence games after participating in the activities. Nine students reported that they enjoyed playing these games and were positively influenced by them. Examples of their responses include:

STU1: "I enjoyed playing mind and intelligence games."

STU10: "It gave me a positive perspective."

Additionally, three students stated that their interest in these games had increased. For example:

STU3: "It created a nice activity environment. I can say that my interest in these games has increased."

Finally, students were asked about the positive effects of mind and intelligence games on their perspectives. One student mentioned that the games improved their ability to make quick decisions, while three students stated that they were able to concentrate better. Examples include:

STU4: "I can say it helped me concentrate better."

STU7: "It improved my focus duration."

In addition to these findings, two students reported that their logical thinking skills had improved, and six students stated that their reasoning abilities had developed. Relevant quotes include:

STU10: "It helped me look at problems from different perspectives."

STU11: "It improved my reasoning skills based on the opponent's moves."

These results highlight the positive impact of mind and intelligence games on students' perspectives, focus, logical thinking, and reasoning abilities.

Findings Related to Question 5

In this section of the study, students were asked whether they would like to participate in future courses or activities related to mind and intelligence games, and if so, the reasons for their willingness to participate.

Table 13. The codes and categories related to Question 4

Questions	Category	Code	f	Participants
Q5. Would you like to participate in future activities and courses related to mind and intelligence games?	Willingness to Participate in Activities/Courses	Yes	12	STU1- STU12
		No	0	-
Q5a. Why would you like to take part in such activities or courses?	Reasons for Participation	Learning new games	1	STU1
		Spending quality/enjoyable time	9	STU1, STU3, STU6, STU7, STU8, STU9, STU10, STU11, STU12
		Cognitive development	2	STU2, STU6
		Educational and instructive	2	STU4, STU5

In this section of the study, students were asked, "Would you like to participate in future activities or courses related to mind and intelligence games?". All students expressed their willingness to participate. As a follow-up, they were asked, "Why would you like to take part in these activities or courses?"

One student stated that their reason for participation was to learn new games, while nine students mentioned that they would participate to have an enjoyable time. Examples of their responses include:

STU1: "To learn more games and have a good time with my friends."

STU7: "To spend time with my friends."

STU10: "Because it is fun."

Additionally, two students indicated that courses related to mind and intelligence games could contribute to their cognitive development. Relevant quotes include:

STU2: "I would like to participate because these types of games could positively impact my cognitive development."

Furthermore, two students stated that they would participate because such courses and activities are both educational and instructive. Examples include:

STU4: "I would like to participate because they are both educational and instructive."

These findings highlight that students are motivated to participate in future courses or activities for reasons such as learning new games, spending quality time with friends, cognitive development, and the educational value of the activities.

Discussion

The study observed a statistically significant increase in the Computational Thinking Scale (CTS) results of participants in the. This finding aligns with a broad body of research; for instance, a directly comparable study by Adalıyılmaz (2022) reported that mind and intelligence games significantly improved students' computational thinking skills. Similarly, Chen et al. (2017) stated that game-based learning is an effective tool for enhancing computational thinking abilities. Román-González et al. (2019) also concluded that game-based learning activities are effective in improving computational thinking skills. Furthermore, the findings of this study are consistent with the research conducted by Brackmann et al. (2017), who found that game-based learning improved computational thinking skills in students aged 10-12, although this improvement was not always statistically significant. Additionally, Tsarava et al. (2019) emphasized that educational games are an effective tool for contributing to computational thinking skills, with their impact becoming more pronounced in the long term.

Qualitative data revealed that students developed a positive attitude toward mind and intelligence games. Students expressed positive opinions about how these games improved their thinking skills, particularly emphasizing advancements in logical reasoning and quick-thinking abilities. These findings are consistent with the results of Devecioğlu and Karadağ (2014), who found that mind and intelligence games enhance logical thinking and problem-solving skills. Students' statements during interviews indicated positive changes in their logical reasoning, problem-solving, and concentration abilities. These results also support the findings of Chen et al. (2017), who highlighted the development of systematic thinking skills. Moreover, these activities help students better analyse problems they encounter in daily life, strengthen their logical thinking abilities, and enhance their problem-solving capacities. Such games contribute not only to students' academic success but also to their social and emotional development. When examining students' opinions on mind and intelligence game activities, it was observed that these games contribute to the development of various cognitive and mental skills. These games help students improve their reasoning abilities, increase their concentration, and make quick and effective decisions. Additionally, these activities reinforce logical thinking skills, enabling students to better analyse and solve problems they encounter in daily life. Such games positively impact students' social and emotional development.

The study revealed a statistically significant increase in the Programming Self-Efficacy Scale (PSS) scores of the experimental group. The observed increase in the PSS scores of the experimental group aligns with Bandura's (2001) view that experiential successes enhance self-efficacy. These findings are also consistent with the research conducted by Román-González et al. (2019), who found that game-based learning improves programming self-efficacy, although this improvement may vary depending on students' prior knowledge levels. The findings also align with Kukul's (2018) research, which concluded that students' programming self-efficacy levels increased. Additionally, during interviews, students stated that they felt confident in their programming self-efficacy. When quantitative and qualitative results are evaluated together, it is evident that the use of mind and intelligence games in algorithm teaching makes students more motivated and effective in their programming learning processes.

To determine how the programming self-efficacy levels of 6th-grade middle school students are influenced by computational thinking skills, the study analyzed data obtained from pre-tests and post-tests conducted during the study. The findings revealed that the educational process strengthened the relationship between students' computational thinking skills and programming self-efficacy levels. The positive correlation between computational thinking and programming self-efficacy supports the study by Ramalingam et al. (2004), which examined the relationship between programming self-efficacy perceptions and mental models. This result indicates that the development of cognitive skills positively influences self-efficacy perceptions. The findings are also consistent with the study by Lye and Koh (2014), which highlighted the positive relationship between programming education and computational thinking skills.

A significant body of research emphasizes the relationship between computational thinking skills and programming abilities. For example, a study by Grover and Pea (2013) examined the impact of computational thinking on programming education and concluded that these skills play a significant role in programming instruction. Wing's (2006) work, which defined the concept of computational thinking and emphasized its importance, also provides a conceptual foundation for these findings. The results of this study connect with the existing literature by demonstrating that computational thinking has the potential to significantly enhance programming self-efficacy. This suggests that acquiring computational thinking skills can improve students' programming competencies, or at least this perceived confidence in those competencies.

Although many studies report positive effects of game-based activities on computational thinking and programming self-efficacy, several researchers note that the evidence is not consistently strong across all contexts. For instance, Güneri and Korkmaz (2023) found that mind-game interventions led to improvements in certain CTS sub-dimensions but did not produce a statistically significant increase in students' overall computational thinking scores. Similarly, recent conference studies such as Rachmatullah et al. (2024) reported non-significant differences between game-based and control groups in programming self-efficacy, suggesting that game-based methods do not always yield measurable gains. In addition, systematic reviews emphasize that results in this field remain mixed, with some interventions showing clear benefits while others demonstrate only limited or domain-specific effects. Together, these findings indicate that while game-based learning holds promise, its impact on CTS and programming self-efficacy is not universally strong and may depend on factors such as intervention duration, game design, and learner characteristics.

Conclusion

This study aimed to examine the impact of using mind and intelligence games in algorithm teaching on middle school students' programming self-efficacy and computational thinking skills. It is suggested that mind and intelligence games can improve students' problem-solving, critical thinking, and algorithmic thinking skills, which play a significant role in programming education.

The findings of the study revealed that the use of mind and intelligence games in algorithm teaching positively influenced middle school students' programming self-efficacy levels. Pre- and post-test evaluations conducted among students showed that those in classrooms where mind and intelligence games were used developed greater programming self-efficacy.

Additionally, evaluations of the impact of using mind and intelligence games in algorithm teaching on computational thinking skills also demonstrated positive effects. It was observed that students in classrooms where these games were used were more effective in problem-solving and algorithmic thinking processes. This supports the idea that mind and intelligence games can strengthen students' computational thinking skills.

This study demonstrated that the use of mind and intelligence games in algorithm teaching can be an effective strategy for improving middle school students' programming self-efficacy and computational thinking skills. These findings provide valuable insights for educators and teachers, emphasizing the importance of incorporating diverse pedagogical methods into programming education.

Future studies could include various methods to better understand the effects of mind and intelligence games and evaluate potential differences among student groups. Additionally, long-term follow-up studies focusing on students' long-term learning outcomes and the sustainable effects of these games could provide more illuminating information in this field.

In this context, factors such as differences in student performance, the learning materials used in education, teacher guidance, classroom interactions, and assessment methods may shape the outcomes. Therefore, it is important for educational programs and pedagogical strategies to focus on more effective and diverse methods to develop students' computational thinking and programming skills. By doing so, potential differences among students can be minimized, and all students can be supported in acquiring these critical skills more effectively. Considering the impact of the educational process on these skills, it is believed that improvements in education have the potential to enhance students' abilities.

This study revealed that the use of mind and intelligence games in algorithm teaching can be a valuable tool for improving students' computational thinking skills and programming self-efficacy. The statistically significant results, combined with students' feedback, demonstrate the educational value of this approach. According to the findings of Plass, Mayer, and Homer (2022), the use of games in education can be an effective method for supporting active learning and achieving learning objectives.

In conclusion, a review of the literature shows that there are many national and international studies examining the impact of using mind and intelligence games in algorithm teaching on middle school students' computational thinking skills and programming self-efficacy. These studies support the idea that mind and intelligence games can be an effective tool for developing computational thinking skills. However, it is evident that long-term and systematic implementations are needed for these effects to emerge. While this study has shown that mind and intelligence games are effective in improving programming self-efficacy, further research is needed in this area.

Recommendation

Building on the study's findings, we recommend diversifying mind and intelligence games to cultivate a broader range of cognitive skills. This approach, supported by Adalar and Yüksel (2017), could incorporate strategy games, logic puzzles, and mathematical problem-solving activities. In practice, this means selecting accessible games aligned with intended learning outcomes; practical examples include Kendoku, Word Ladder, Sudoku, Fence Puzzle, Hex, and general brain teasers.

To integrate these games more effectively into curricula, interactive learning platforms can be used to enable play, collaboration, and feedback, thereby enhancing engagement and deepening learning (Plass, Mayer, & Homer, 2022). Embedding games in workshops and project-based tasks that address contemporary, real-world problems can further promote skill transfer and strengthen algorithmic thinking (Román-González, Pérez-González, & Jiménez-Fernández, 2019). Finally, additional research should systematically examine impacts on programming skills using rigorous designs and mixed methods, with attention to achievement, motivation, and learning processes to inform instructional strategy.

Recommendations for Educators

- Mind and intelligence games can be utilized as supportive materials in algorithm teaching.
- The selection of games should take into account students' interests and proficiency levels.
- Group activities should be emphasized more than individual work during educational practices.
- The variety of games can be increased by considering available resources and introducing new games.

Recommendations for Researchers

- Implementing applications with more appropriate durations may lead to better outcomes.
- Similar studies can be replicated with different age groups.
- The effectiveness of different types of games can be compared.
- Broader studies can be designed and conducted using either quantitative and qualitative methods together or separately.

Recommendations for Program Developers

- Mind and intelligence games can be systematically integrated into the curriculum.
- Game-based approaches can be developed for programming education.
- Topics related to mind and intelligence games can be included in teacher training programs at universities and in professional development programs for educators.

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Appendix

Information about the games used in the study is given below.

Mangala

Mangala, a strategic game played by two players, has its roots in the ancient Ottoman Empire. Each player is given 24 tiles to start the game, which consists of 48 tiles in total. The Mangala game board has 14 wells: six small ones for each player and one large treasure well where each player can collect their pieces. Initially, four tiles are placed in the smaller wells. The six wells in front of a player on the Mangala board represent their own territory, while the opposing player's wells are considered their territory. The object of the game is to collect the most tiles in the treasure wells. At the end of the game, the player who collects the most tiles is declared the winner of that set. A total of three sets is played throughout the game, and the final winner is determined by the number of sets won. Mangala follows four basic rules.

- The player who wins the toss takes a tile from a well in the designated area, leaves one in the original well, and distributes the remaining tiles to the wells to the right, one at a time. If the last tile falls into the treasure well, the player moves again. The player with a stone in their hole completes their move by transferring it to the hole on the right and passes their turn to their opponent. The key to the game is determining which hole the last stone will land in.
- The player strategically distributes the stones in their own hole and places the remaining stones in their opponent's hole. If the last stone lands in their opponent's hole and the number of stones in that hole is even, they collect all the stones and add them to their treasury. Then, the opponent's turn passes.
- If the player distributes the stones and places the last stone in the empty hole on their side of the field, they collect the stones opposite the opponent's empty hole and one stone from their own hole and add them to their treasury. Then, the opponent's turn passes.
- When a player has used up all the stones in their hole, the game ends when they capture the remaining stones from their opponent's hole.

The students were given the Mangala game and distributed according to the number of students present. The students formed pairs with their chosen friends to play. Initially, the students had difficulty grasping the rules. However, after playing the game again, they implemented the rules to make the game more enjoyable and accessible.

Experimental group students playing the Mangala game

Reversi

Reversi is a strategic activity designed for two players. The game consists of 64 tiles, one side black and the other white. Players divide the 32 tiles equally. The game board consists of 64 squares, with two black and two white tiles placed diagonally in the center. One player chooses black, the other white, and the game begins with the black color. The goal is to convert the opponent's tiles to their own color by trapping them between their own tiles and flipping all surrounding tiles vertically, horizontally, and diagonally. Each player taking their turn must strategically position their opponent's tiles among their own-colored tiles. For players seeking victory, strategically placing their own-colored tiles in the corners of the board is advantageous. After all the tiles are placed, the player who collects the most colored tiles is declared the winner, signaling the end of the game. The Reversi game used in the study has been a tool for developing students' problem-solving and social skills. These two-player games were presented to students in a classroom setting. Some students played multiple matches in a row during a single lesson, while others completed their games after a single game.

Experimental group students playing the Revesi game

Koridor (Corridor)

The corridor game, also known as a maze, obstacle, or block, is a board game consisting of a 9x9 board with 81 squares, 20 obstacle tiles, and two pawns. This game is designed for two players, each with 10 obstacle tiles and one pawn. A pawn is initially placed in the center of the first row, while obstacles are positioned at the end of the board. The object of the game is to move your pawn toward your opponent's starting square. Victory is achieved when a player successfully moves their pawn to any of the nine squares on their opponent's first row. However, the opponent can hinder progress by strategically placing obstacle tiles to block the pawn's path. On their turn, players have the option of moving their pawns or placing an obstacle. Pawns can be moved one square at a time, forward, backward, right, or left, but they are not allowed to move diagonally or jump over obstacles. In competitive play, it is crucial for players to remember the importance of giving their opponents a chance to advance. This concept, known as corridor play, is not unfamiliar to them. The students were well aware of this strategy and it became a recurring theme during the lesson. They also took turns taking on the role of the opposing team.

Experimental group students playing the Koridor game

Equalibrio

Equilibrio, also known as Smart Buildings, is a captivating board game that can be played both individually and in groups. This game features 18 unique geometric blocks, each with its own unique shape, such as a cylinder, rectangular prism, triangle, and semicircle. These blocks are accompanied by a comprehensive game booklet that provides instructions and challenges. The goal of the game is to skillfully arrange the blocks to recreate the three-dimensional models depicted in the booklet. To assist players, the blocks required for each model are conveniently listed at the bottom of each page. Students were even more intrigued when they discovered this engaging game. They participated in the turn-based gameplay and thoroughly immersed themselves in the excitement and fun that Equilibrio brings.

Experimental group students playing the Equilibrio game

Trafik (Rush Hour)

The game features 40 mission cards and 16 vehicles, each with varying difficulty. Vehicles are strategically positioned on the playing field based on the selected card. The goal is to maneuver other cars and trucks only forward or backward to free the red car from a dead end. Players place vehicles on the playing field according to the instructions on the mission cards and attempt to free the red car from traffic. Vehicles can only be moved forward or backward, and no vehicle can be removed from the playing field. These restrictions require players to think strategically.

Experimental group students playing the Rush Hour game