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The Impact of Educational Puzzle Games on the Cognitive Development of Children

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ABSTRACT

Educational games play a vital role in supporting early childhood cognitive development through activities that stimulate motor skills, creativity, language, and logic while enhancing concentration, imagination, and learning engagement. This study aims to identify the differences in children's cognitive abilities before and after receiving an intervention through puzzle play as a learning stimulus. The research employed a quantitative approach with a one-group pretest-posttest design, involving 12 early childhood education students as the total sample. Data were collected through observation and analyzed using a Paired Sample t-Test. The analysis showed a significant difference between pre- and post-test scores, with a t-value of -10.721 and a significance level of 0.000, lower than 0.05. This indicates that puzzle play has a statistically significant positive effect on children's cognitive development. The mean difference of -5.333 suggests improvement after the intervention. Puzzle activities train logical thinking, instruction comprehension, and problem-solving skills. The teacher's role is essential in guiding the process. Conclusion: Puzzle play effectively enhances early childhood cognitive development by significantly improving concentration, logic, independence, and problem-solving in an enjoyable learning environment.

Keywords: *Early Childhood, Educational Games, Puzzle, Cognitive Development.*

A. INTRODUCTION

Early Childhood Education plays a crucial role in supporting the holistic development of children, encompassing academic, emotional, and social aspects essential for the child's well-being and future success (Viejo et al., 2018). In early childhood education, educators require specialized training in designing, implementing, and evaluating age-appropriate curricula aligned with children's motivation. Play constitutes a fundamental component of early childhood education, as through play, including traditional games, children develop cognitive, social, emotional, and physical skills, while also building resilience, self-esteem, and cultural appreciation (May et al., 2018; Mwinsa & Dagada, 2025). Moreover, early childhood education prepares children for entry into formal schooling by reinforcing foundational skills across various developmental domains (Pewa & Mzimela, 2024; Om, 2022).

The role of educators in early childhood education is pivotal, particularly in delivering responsive and intentional teaching practices to support children's social-emotional

competencies (Aspden et al., 2021). Parental involvement significantly contributes to child development, especially in fine motor skills. A lack of parental knowledge may hinder developmental progress; thus, parental education is essential (Aini et al., 2020). Technology also holds potential to support engaging learning experiences; however, limitations in resources and training present significant challenges in its implementation (Ogegbo & Aina, 2020). Divergent perspectives among stakeholders regarding the essential skills for children necessitate adaptive policies and professional training (Dilek, 2025), as well as curricular continuity between early childhood education and primary school (Gençten, 2022), including maintaining balanced quality in teacher-child interactions (Rüdisüli et al., 2024).

Cognitive development in early childhood education is critical as the foundation for future learning, critical thinking, problem-solving, and creativity (Montano-Silva et al., 2025). The early years, from birth to six, are characterized by significant changes in cognitive processes such as acquiring, organizing, and applying knowledge (Gauvain & Richert, 2023). Classical theories, such as Piaget's genetic epistemology and Vygotsky's historical-cultural theory, emphasize the importance of developmental stages and information processing (Arranz-Freijo et al., 2019). Effective strategies include game-based learning, movement and sound play, and nature-based approaches. These methods have been shown to enhance children's memory, critical thinking, self-regulation, and social development (Annuar et al., 2025; Sriwidaningsih & Friskawati, 2022; Johnstone et al., 2022).

The roles of parents and educators strongly influence the cognitive development of young children. Parents' perceptions of their children's intelligence can affect cognitive development, although these perceptions do not always align with objective measures (Chung et al., 2019). Effective management of early childhood education operational assistance programs ensures the availability of facilities and learning resources to support children's cognitive growth (Baidowi, 2020). Proper curriculum planning in early childhood education improves educational quality by aligning learning activities with children's developmental stages, thereby maximizing cognitive stimulation (Marjuki & Baidowi, 2023). Digital learning must be balanced with physical activity to avoid disrupting children's executive functioning (Rathnayaka et al., 2023). Cultural and social factors also play a significant role in cognitive development, making it important for early interventions to consider these aspects (Casey et al., 2021). Proper playgroup management enhances children's cognitive stimulation (Baidowi & Widyaningsih, 2022).

Using Educational Play Tools is crucial in stimulating cognitive development in early childhood through educational play activities (Anggraeni et al., 2024). One effective type of educational play is beading activities, which contribute to the development of fine motor skills and cognitive growth (Farida & Yanti, 2023). Playing media such as number cards also helps introduce numerical concepts and support cognitive development (Survia & Mulanirum, 2023). Finger painting is also an educational play activity that trains fine motor skills while stimulating creativity and exploration, positively impacting children's cognitive development (Farida & Rahayu, 2023). The application of Piaget's theory in early childhood education underscores the importance of activities corresponding to developmental stages to optimally support cognitive growth (Khotimah & Agustini, 2023).

The impact of educational play on cognitive development in early childhood education is

highly significant. Educational games like interactive mobile games can enhance children's language skills, critical thinking, emotional development, and imagination (Ni & Yu, 2015). Furthermore, games like playdough are effective in helping children recognize symbols, numbers, and letters, which are important for basic cognitive development (Rukmini et al., 2022). Interactive didactic games provide immediate feedback, enjoyably stimulating learning (Baikulova et al., 2024). However, educational content in commercial games is often inadequate; thus, games tailored by educators are necessary. Integrating educational games into the curriculum can maximize intellectual benefits and prepare children to face future academic challenges (Izat et al., 2025).

Social and emotional development in children can be supported through play-based learning that enhances engagement, motivation, and enjoyment, which are important aspects of cognitive, social, and emotional growth (Alotaibi, 2024). Educational games also effectively manage behavior and improve concentration and engagement (Boussaha et al., 2025). Nevertheless, parental control over content and playtime strongly influences children's behavior and cognitive development (Kamenar Čokor & Bernik, 2021). Moreover, serious game-based learning frameworks that integrate cognitive theory and instructional content have improved cognitive abilities in children with cognitive deficits (Dong et al., 2024).

Previous studies have extensively discussed the influence of digital educational games on cognitive development; however, quantitative research focusing on puzzle games at Raudhatul Athfal Daaruth Thoriiqul Manshur remains limited and does not sufficiently emphasize the teacher's role in guiding play activities as a learning stimulus. This study addresses this gap by employing an experimental design with a one-group pretest-posttest approach to directly measure the effect of puzzle games on the cognitive development of early childhood children. The research objective is to identify changes in cognitive abilities before and after the intervention using puzzle games. Significant results demonstrate improved logical thinking, shape and pattern recognition, memory, concentration, and problem-solving skills. These findings confirm the effectiveness of puzzle games as an enjoyable cognitive stimulation strategy that should be integrated into the learning process at Raudhatul Athfal Daaruth Thoriiqul Manshur, with teachers playing an active role as facilitators of the learning process.

B. RESEARCH METHOD

This study employed a quantitative approach with a one-group pretest-posttest design. This design involves a single group of subjects who receive a treatment, with measurements taken both before (pretest) and after (posttest) the treatment. The purpose is to determine the effect of the administered treatment, namely educational puzzle games, on children's cognitive development at Raudhatul Athfal Daaruth Thoriiqul Manshur. The population in this study consisted of all students at one of the Raudhatul Athfal Daaruth Thoriiqul Manshur institutions, with a sample size of twelve students from class B. The sampling technique was total sampling, as the small population size allowed the entire population to be used as the sample. Data was collected by directly observing the children's cognitive development before and after the puzzle game intervention. The assessment instrument consisted of an observation sheet using a three-point Likert scale: a score of 3 indicating Good, 2 indicating Adequate, and 1 indicating Poor. The instrument details are presented in the following tables:

Table 1. Observation Sheet for Children's Use of Puzzle

Variable	Indicator	Observation Statement	Score 3	2	1
Puzzle Usage(Chandra, 2019)	Teacher gives instruction	The child/student pays attention to the teacher to observe the picture or shape of the puzzle before playing			
	Teacher gives instruction to dismantle puzzle	The student can carefully remove puzzle pieces one by one without damaging the image.			
		The student can scramble all puzzle pieces so they no longer form a complete picture.			
		The student shows independence when dismantling the puzzle without much assistance from the teacher or peers.			
	Teacher gives instruction to assemble puzzle	The student is able to reassemble the puzzle pieces into the correct position to form a complete picture.			
		The student demonstrates perseverance during the puzzle assembly process.			
		The student shows concentration during the puzzle assembly process.			

Table 2. Observation Sheet for Early Childhood Cognitive Development

Variable	Indicator	Observation Statement	Score 3	2	1
Early Childhood Cognitive Development(Ministry of Education and Culture Regulation Number 137 Year 2014)	Learning and Problem Solving	The child attempts various ways to assemble the puzzle, even after several mistakes, then corrects it independently.			
		The child can complete the puzzle without direct assistance from the teacher, demonstrating understanding and initiative.			
	Logical Thinking	The child can recognize image patterns and determine the appropriate position for each piece.			
		The child groups puzzle pieces based on similar colors or shapes before assembling them.			
		The child understands that placing pieces incorrectly will prevent the picture from forming correctly.			
	Symbolic Thinking	The child assembles the puzzle according to shape and position.			
		The child shows imagination by describing the content of the picture after completing the puzzle.			

Data analysis consisted of several stages. Descriptive analysis was used to describe the results of observations before and after the treatment. The validity of the instrument was tested using the Statistical Package for the Social Sciences (SPSS) on the observation items, with results indicating that all items had a Corrected Item-Total Correlation value above 0.3 and were significant ($p < 0.05$), thus confirming the instrument's validity. Subsequently, classical assumption tests were conducted to ensure data suitability before hypothesis testing. After confirming data validity, hypothesis testing was performed using the Paired Sample t-Test to determine significant differences between pretest and posttest results. The t-test results indicated a significance value (two-tailed) of $0.000 < 0.05$, leading to the rejection of the null hypothesis and acceptance of the alternative hypothesis.

This study hypothesizes that educational puzzle games affect children's cognitive development in early childhood education.

The research design can be illustrated as follows:

O1	**X**	**O2**

Gambar1. *One Group Pretest-Posttest*

Explanation**:**

- O_1 = Pretest / Test before the Puzzle Game treatment
- X = Administration of the Puzzle Game treatment

- O_2 = Posttest / Test after the Puzzle Game treatment
- O_1 - O_2 = Effect of the Puzzle Game on Children's Cognitive Development

C. RESULTS AND DISCUSSION

1. Descriptive Analysis of Children's Puzzle Game Results (X)

Table 1. Descriptive Analysis of Children's Puzzle Game Results

No	Student Name	Total Score	Average Score
1	Student 1	18	2,6
2	Student 2	14	2,0
3	Student 3	15	2,1
4	Student 4	12	1,7
5	Student 5	11	1,5
6	Student 6	19	2,7
7	Student 7	18	2,6
8	Student 8	16	2,3
9	Student 9	16	2,3
10	Student 10	17	2,4
11	Student 11	12	1,7
12	Student 12	16	2,3

Based on the descriptive analysis of the children's puzzle game results (X) using a 3-point Likert scale, where a score of 3 indicates "Good," 2 indicates "Adequate," and 1 indicates "Poor," data collected from twelve students showed the highest total score of 19 (Student 6) and the lowest total score of 11 (Student 5). The average scores ranged from 1.5 to 2.7. The individual average scores ranged between 1.5 and 2.7, which, when converted to the Likert categories, indicate that three students (Students 1, 6, and 7) were classified as "Good" (average $\geq$ 2.5). The remaining nine students fell within the "Adequate" category (average between 1.5 and 2.4). No students were classified as "Poor" (average < 1.5). Therefore, it can be concluded that most students (75%) demonstrated an adequate ability to complete the puzzle, whereas only a small portion (25%) showed good performance, and none showed poor results. This suggests that all students understood basic skills related to playing puzzles.

2. Descriptive Analysis of Students' Cognitive Development Before Treatment (O1)

Table 2. Descriptive Analysis of Students' Cognitive Development Before Treatment

No	Student Name	Total Score	Average Score
1	Student 1	13	1,9
2	Student 2	14	2,0
3	Student 3	11	1,6
4	Student 4	12	1,7
5	Student 5	14	2,0
6	Student 6	10	1,4
7	Student 7	12	1,7
8	Student 8	11	1,6

9	Student 9	13	1,9
10	Student 10	11	1,6
11	Student 11	10	1,4
12	Student 12	12	1,7

Based on the descriptive analysis of students' cognitive development before the puzzle game treatment (O1), which was assessed using a 3-point Likert scale (3 = Good, 2 = Adequate, 1 = Poor), data from twelve students revealed a highest total score of 14 (Students 2 and 5) and a lowest total score of 10 (Students 6 and 11). The average scores ranged between 1.4 and 2.0, which, when translated into Likert categories, show that the majority of students were in the "Adequate" category (1.5–2.4), while a few students were at the lower boundary of the "Poor" category (1.0–1.4). No students reached the "Good" category (≥ 2.5). This indicates that before receiving the puzzle game intervention, the cognitive development levels of the students were generally moderate to low, with most students demonstrating cognitive abilities at an adequate level. At the same time, some required further attention and guidance to improve their basic cognitive skills.

3. Descriptive Analysis of Students' Cognitive Development After Treatment (O2)

Table 3. Descriptive Analysis of Students' Cognitive Development After Treatment

No	Student Name	Total Score	Average Score
1	Student 1	16	2,3
2	Student 2	18	2,6
3	Student 3	15	2,1
4	Student 4	15	2,1
5	Student 5	16	2,3
6	Student 6	14	2,0
7	Student 7	15	2,1
8	Student 8	16	2,3
9	Student 9	17	2,4
10	Student 10	16	2,3
11	Student 11	16	2,3
12	Student 12	15	2,1

Based on the descriptive analysis of students' cognitive development after the puzzle game treatment (O2), assessed using the same 3-point Likert scale, data from twelve students showed the highest total score of 18 (Student 2) and the lowest total score of 14 (Student 6), with average scores ranging from 2.0 to 2.6. When categorized according to the Likert scale, the majority of students were classified as "Adequate" (1.5–2.4), with several students achieving the "Good" category (≥ 2.5), such as Student 2 with an average score of 2.6. No students fell into the "Poor" category (< 1.5). Overall, there was an observable improvement in cognitive development compared to before the treatment, as evidenced by the increased number of students approaching or attaining the "Good" category and the absence of students in the low category. This demonstrates that the

administration of puzzle games positively impacted the students' cognitive development.

4. Inferential Data Analysis

Data Validity

Table 4. Data Validity

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Before Puzzle	22.4167	2.811	.593	.
After Puzzel	17.0833	4.265	.593	.

Based on the validity test using the Corrected Item-Total Correlation technique, the items "Before Puzzle" and "After Puzzle" yielded a correlation value of 0.593. This value exceeds the critical r-table value of 0.576 at a 5% significance level with 10 degrees of freedom (df). This indicates that both items have a significant correlation with the total scale score, and thus, the items "Before Puzzle" and "After Puzzle" are considered valid. In other words, these items adequately measure the cognitive development aspects of the students and are suitable for use as research instruments.

5. Hypothesis Testing (t-Test)

Table 5. t-Test Result

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Before Puzzle - After Puzzel	-5.33333	1.72328	.49747	-6.42825	-4.23841	-10.721	11	.000

The results of the paired samples t-test on the scores "Before Puzzle" and "After Puzzle" show a calculated t-value of -10.721 with 11 degrees of freedom (df = 11) and a significance value (Sig. 2-tailed) of 0.000. Compared to the critical t-value of ±2.201 at the 5% significance level ($\alpha = 0.05$) and df = 11, the calculated t-value (-10.721) lies far beyond the acceptance range (-2.201 to +2.201), and the significance value is well below 0.05. These results indicate that the mean difference between pre-treatment and post-treatment scores is statistically significant. Furthermore, the mean difference of -5.333 suggests that the "After Puzzle" scores are higher than the "Before Puzzle" scores. Therefore, it can be concluded that the provision of the puzzle game has a significant positive effect on students' cognitive development at Raudhatul Athfal Daaruth Thoriiqul Manshur.

This finding means that puzzle games significantly enhance cognitive development, especially in early childhood. This can be explained by linking it to the puzzle usage indicators proposed by Chandra (2019) and the cognitive development indicators for early childhood outlined in Permendikbud Number 137 Year 2014. During the puzzle activity, the teacher actively provides instructions on how to disassemble and assemble the puzzle. This activity trains children to understand instructions, follow logical sequences, and systematically arrange parts. Such processes contribute to learning and problem-solving skills, where children must find solutions to assemble puzzle pieces correctly. Moreover,

assembling puzzles stimulates logical thinking, as children are challenged to recognize patterns, shapes, and relationships between parts.

Puzzle games for early childhood have been proven to significantly impact children's cognitive, motor, social, and emotional development. In the cognitive domain, digital and traditional puzzles significantly improve children's learning outcomes, as shown in research comparing learning results before and after using culturally-based digital puzzle media (Asmawati, 2023). Traditional puzzles, such as wooden or cardboard puzzles, also stimulate cognitive functions in children aged 4 to 5 years (Pratiwi et al., 2020). The use of visual interfaces, sounds, and animations in digital puzzles supports interactive and multisensory learning (Wang et al., 2023). In the motor domain, puzzle games help improve coordination, balance, and fine motor skills, such as grasping and manipulating objects (Terrazzo-Luna et al., 2024). From a socio-emotional perspective, puzzles encourage interaction and cooperation among children, fostering cooperative attitudes and reducing aggressive behaviors (Chang & Yen, 2023; Kristianti et al., 2018). Additionally, puzzle games' easy-to-use, adaptive, and developmentally appropriate design plays a crucial role in their effectiveness as educational media (Sánchez et al., 2018). Therefore, puzzle games can serve as comprehensive educational tools to support holistic development in early childhood.

D. CONCLUSION

Puzzle games positively impact the cognitive development of early childhood children. Most children demonstrated a good ability to complete the puzzle games, while some performed excellently. No child experienced significant difficulty or fell into the low ability category. Before the intervention through puzzle-playing activities, the children's cognitive development level was generally moderate, with some children exhibiting below-average abilities. However, after receiving the treatment in the form of puzzle games, a noticeable improvement was observed in their thinking skills and task comprehension. The children appeared more focused, active, and capable of completing challenges independently and systematically. This improvement is also reflected in the shift of children's ability categories from average or low to average or good after participating in the puzzle games.

The puzzle games have been proven to stimulate cognitive development, particularly in concentration, logical thinking, and problem-solving skills. Regarding the measurement instruments used, the analysis results indicate that the tools were valid and reliable in assessing children's cognitive development. Furthermore, inferential analysis reinforced the descriptive findings by showing a statistically significant difference between pre- and post-treatment conditions. This clearly demonstrates that puzzle-playing activities are not only enjoyable but also possess high educational value. Therefore, puzzle games can be recommended as an effective learning method to support the cognitive development of early childhood children through active and engaging learning activities.

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in the learning process. We appreciate the opportunities and trust provided by the school, teachers, and parents who actively participated. We hope the results of this study contribute significantly to the development of effective and enjoyable educational methods and serve as a foundation for further cognitive stimulation programs for early childhood in the future.

AUTHOR CONTRIBUTIONS

Author 1 : Designed and implemented the One Group Pretest-Posttest experimental design, developed measurement instruments, managed data collection, and analyzed the results systematically and validly to assess the impact of puzzle games on the cognitive development of early childhood children.

Author 2 : Designed research methodology, developed field instruments, and refined instruments.

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