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Transforming Pedagogy with Digital Games: Tapak Nusantara as a Tool for Early Childhood Critical Thinking Development

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ABSTRACT

Objective: This study explores pedagogical transformation in early childhood education through digital game-based learning by developing Tapak Nusantara, a digital adaptation of the traditional crankle game. Integrating pedagogical principles in game-based learning is crucial for fostering critical thinking in young learners. This research bridges cultural pedagogy with digital learning, ensuring children acquire meaningful educational experiences while preserving Indonesian culture. **Method:** This research is development research with a 4D model approach. The subjects of this study were 53 children in IT Nada Ashobah kindergarten class B and Labschool Unesa kindergarten class B. **Results:** This study showed a significant difference between the crankle traditional and crankle traditional games. The results of this study showed a significant difference between the pre-test and post-test scores in both the Nada Ashobah IT Kindergarten ($t = -8.494$, $p < 0.001$) and Labschool ($t = -5.783$, $p < 0.001$) groups, which indicated the effectiveness of the game in improving children's critical thinking. **Novelty:** This research lies in three key contributions: (1) the pedagogical innovation of integrating game-base learning with cultural education, (2) the digital transformation of a traditional game into a developmentally appropriate learning tool, and (3) Tapak Nusantara representative culture, pedagogy, and technology to cultivate critical thinking for early childhood.

INTRODUCTION

The rapid advancement of digital technology has undeniably transformed various aspects of education, especially in early childhood learning. Today, as children grow up in a technology environment, integrating digital tools into their education is no longer essential. The development of digital technology has resulted in children's learning at this age (Meng, 2023). Technology is used as a learning medium. Game-based learning is an educational innovation that stimulates children's cognition, including critical thinking (Hussein, 2019). For early childhood, critical thinking is needed; this ability is related to analyzing information, solving problems, and making decisions based on logic (Mohammed, 2023).

In early childhood, the development period requires appropriate stimulation and specific conditioning to suit learning objectives. As with critical thinking in early childhood, it cannot just appear but must come from learning experiences that children's curiosity (Afidah, 2024). However, the challenge in designing developmentally appropriate digital games that stimulate the critical thinking processes (Gurbuz & Celik, 2022; Mao et al., 2021; O'Reilly et al., 2022; Sen et al., 2021; Xiong et al., 2022). Providing stimulation in early childhood requires challenging and interactive activities so that children do not feel bored and are encouraged to find out. Game-based learning can be an effective medium for creating a fun learning environment while encouraging children to be reflective and logical to have valuable

play experiences (Lamrani, 2020). Therefore, game-based learning as a medium to develop early childhood critical thinking is not just a trend but a necessary adaptation to modern learning needs.

The gap in this research: Despite the promising potential of digital game-based learning, its implementation in early childhood education remains limited and underexplored. Many existing educational games lack cultural relevance and do not align with the developmental needs of children. Furthermore, although digital games have been widely studied, research integrating local cultural elements into game-based learning for critical thinking is still scarce. However, the most current digital learning tool prioritizes structured pedagogical design, leading to limited educational outcomes (Al-Gerafi et al., 2024; Julia et al., 2021; Okoye et al., 2023; Rafiq et al., 2024; Theelen & van Breukelen, 2022). To bridge this gap, this study develops game-based learning called Tapak Nusantara to foster critical thinking in children while interacting with elements of Indonesian culture.

Game-based learning is a type of game designed with a specific purpose in learning. Game-based learning places children at the center of learning by utilizing digital or electronic games as learning tools (Liu, 2020). Games are used as a medium to convey material, increase understanding and knowledge, and conduct an assessment or evaluation of a field of knowledge (Wulan, 2023). The selection of appropriate media in game-based learning involves considering the ability and characteristics of the media to support various learning components. Developing game-based learning can create a motivating and fun environment for children. Game-based learning can stimulate children's critical thinking, so it becomes an interesting solution for teachers to improve children's critical thinking skills (Hussein, 2019).

Critical thinking involves understanding and exploring an idea in depth by comparing, analyzing, and finding alternative solutions. It also reflects curiosity, the skills to ask questions, find answers, assess things, make decisions, express opinions, and argue (Aston, 2023a). Critical thinking skills can begin to be developed from an early age. Children naturally show signs of critical thinking when they begin to observe their surroundings with curiosity (Fita et al., 2021; Kewalramani et al., 2021; List, 2022; Ramanathan et al., 2024; Salmon & Barrera, 2021). Although not yet as complex as adult thinking, this development occurs in the cognitive stage experienced by children. Therefore, a supportive environment is needed so that children get the right stimulation to develop their critical thinking skills.

The study aims to first develop a game-based learning game, the tread culturepelago game. The tread culturepelago game is the development of a base learning game based on the traditional game of crankle changed to digital. The basis for this change is the adjustment between the current early childhood understanding of traditional games that is minimal and adjusting to digitalization (Turen, 2024). Second, we will evaluate the effectiveness of Tapak Nusantara's impact on critical-thinking children. Compare the effectiveness of Tapak Nusantara across different early childhood education settings to assess its applicability and scalability. This new innovation is presented in the context of the type of player and the material content in the tread culturepelago game. The content of this game presents cultural customs in Indonesia, including traditional clothes, traditional houses, and regional food.

Compared to others, The novelty of this game is aimed at children's critical thinking, so the way to play the game is made like a crankle. However, the content is equipped with Indonesian culture so that children can mention the differences in characteristics easily recognized from the visual symbols and the audio. This game teaches children about culture through engaging visuals and appropriate content. In

implementing the game, children are invited to complete tasks and challenges designed for children's critical thinking, such as analyzing cultural patterns, developing strategies by distinguishing various cultures, and making decisions (Nyameky, 2024).

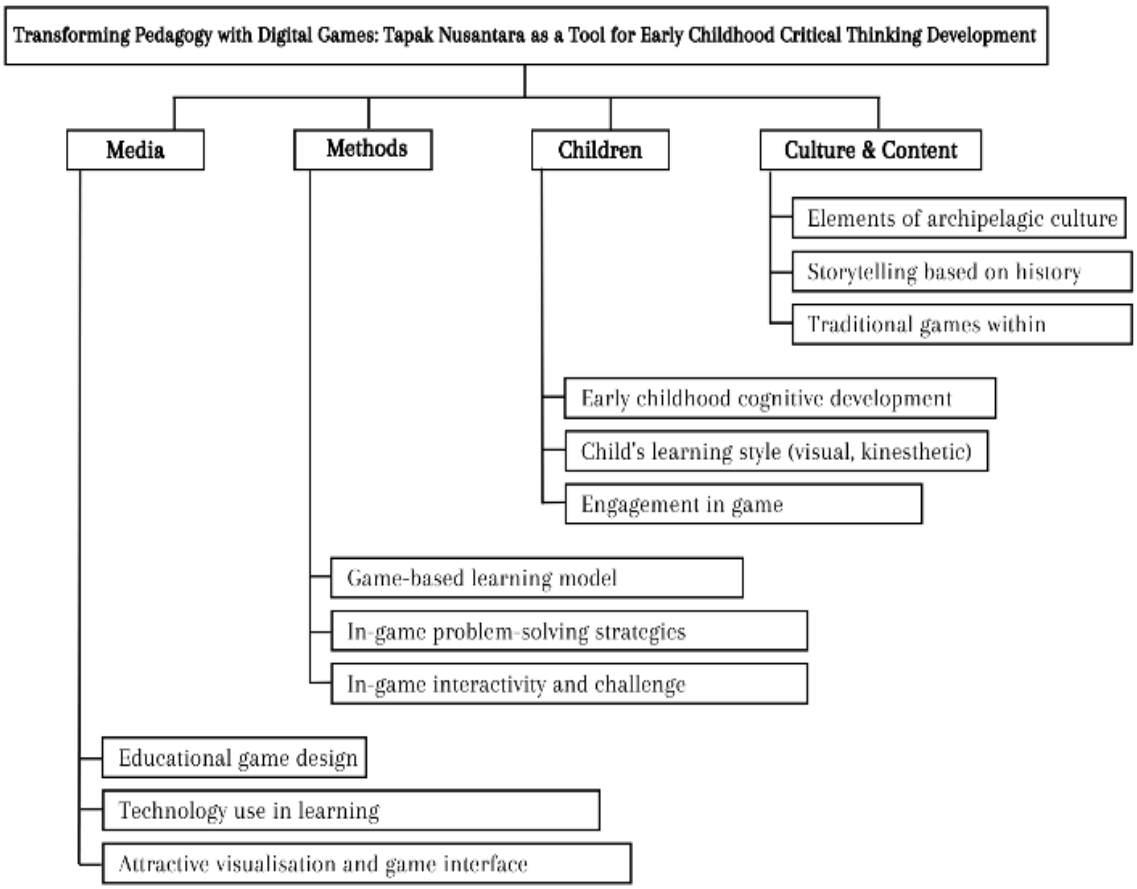


Figure 1. The flow of thinking and novelty in this research.

Previous research has shown that digital-based educational games can improve children's critical thinking skills, especially in the context of exploratory and experiential learning. From 100 articles in the last 5 years, few studies specifically examine how games with local cultural elements can contribute to the development of critical thinking in early childhood. Therefore, this study aims to develop and test the effectiveness of the Tapak Nusantara Game in improving early childhood critical thinking skills. Figure 1 shows the explanation of the flow of thinking and novelty in this research so that it can hone critical thinking in early childhood. Referring to this background, developing a base learning tread culture game is needed to introduce local culture through digital media and sharpen critical thinking in early childhood. The game developed transforms traditional games into digital ones by maintaining classic game elements while enriching them with educational content. Tapak Nusantara combines cultural exploration elements with digital game mechanics, unlike other base learning games. In its development, this game is designed to provide a meaningful learning experience for children. The research will assess how this culturally enriched game design can effectively sharpen critical thinking abilities in early childhood, filling a gap in existing literature and providing valuable insights into the role of culture in digital learning.

RESEARCH METHOD

Research Design

This study uses research and development with a 4D design (Define, Design, Develop, Disseminate), which is defined as a research method aimed at finding, formulating, improving, developing, producing, and testing the effectiveness of products, models, methods, or strategies (Thiagarajan, 1974). The research step that the author uses is the 4D model. The research stage of the 4D model development. This 4D model consists of defining (Defining), designing (Designing), developing (Developing), and disseminating or testing (Disseminating). This study focuses on developing the Tapak Nusantara game to stimulate critical thinking in early childhood. The research design can be seen in Figure 2.

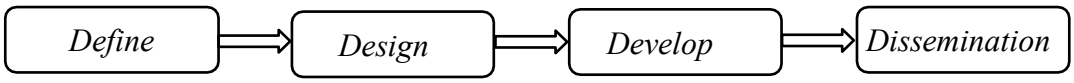


Figure 2. Research design.

Subject

This research was conducted on kindergarten B class children aged 5-6 at IT Nada Ashobah Kindergarten and Labshool Surabaya Kindergarten. Table 1 shows the distribution of child data.

Table 1. Distribution of child data.

School Name	Boys	Girls
IT Nada Ashobah Kindergarten	14	13
Labschool Kindergarten	16	10

Research Procedure

The stages of this research follow the 4D Model process. The first stage is Defined; at this stage, the initial identification of the Tread Nusantara Game development characteristics is carried out. The initial analysis process is carried out by identifying the problem of learning media for critical thinking in early childhood and then assessing the role of game-based learning in stimulating children's critical thinking. After the initial analysis, a learner analysis was conducted to determine the developmental characteristics and critical thinking indicators that would be stimulated. Content analysis was carried out by integrating traditional crankle games, cultural content, and play mechanisms that support early childhood. After completing the analysis stage, the second stage is the design stage, the initial design of the Culture Tread game; at this stage, the game flow is determined, the development of the storyboard and includes cultural elements in the game. At the end of this second stage, an evaluation instrument is designed consisting of instruments, assessment rubrics, pretest, and posttest designs.

The third stage is development; the primary purpose of this third stage is to develop game prototypes and digital-based games according to the design that has been done, involving validators in the preparation so that the games produced are based on the characteristics of early childhood. The test was conducted on kindergarten B children from 2 schools, namely IT Nada Ashobah Kindergarten and Labshool Unesa Kindergarten which had homogeneous characteristics. The fourth stage is discrimination, which all teachers in both schools carry out; this is intended to

convey the ease of the game to stimulate children's critical thinking so that it can be used sustainably.

Instruments and Procedures

The instrument developed in this study refers to Facione on critical thinking, with adjustments to the characteristics of children aged 5-6 years. The form of the instrument is an observation sheet of children's critical thinking to determine objectivity; the instrument is equipped with an assessment rubric. The following are the instrument development and validation results in Table 2.

Table 2. The results of instrument development and validation.

Indicator	Assessed Aspect	Validation
Analysis Skills	Distinguish objects and characters in the game	Valid
	Explaining the relationship between objects in the game	Valid
Inference Skills	Predicting the next move in the game	Valid
	Determine solutions to game challenges	Valid
Reflective Thinking	Evaluate decisions made in the game	Valid
	Give reasons for the decision taken	Valid

Data analysis

This study collected data through pre-tests and post-tests to measure the improvement of children's critical thinking before and after playing the Tapak Nusantara Game. A paired t-test was used to analyze the difference in pre-test and post-test scores in two groups, namely the IT Nada Ashobah Kindergarten and Labschool Kindergarten groups.

RESULTS AND DISCUSSION

Results

The research questions in this study are the development process of Tapak Nusantara and how effective the Tapak Nusantara game is in improving critical thinking in early childhood. The results of this study will be described by the procedure that has been arranged below:

a. Developing process: Define, Design, Develop and Disseminate
   1) *Define*

      This initial stage aims to identify the characteristics of game development based on the needs of early childhood. An initial analysis was conducted on the problems of learning media that support critical thinking in early childhood and studies on the effectiveness of *game-based learning* in stimulating critical thinking skills. In addition, a child analysis was conducted to understand the developmental characteristics and critical thinking indicators that need to be stimulated in the game. The game content was developed by integrating traditional crankle games and elements of Indonesian culture, including play mechanisms suitable for early childhood.



Image1 . Game Start View



Image2 . Play Character Selection Menu

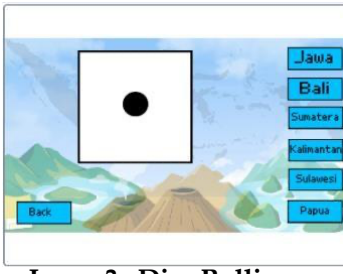


Image3 . Dice Rolling Menu

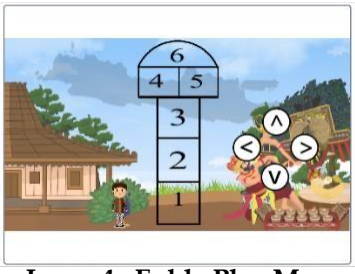


Image4 . Enkle Play Menu



Image5 . Playing Cards Menu



Image6 . Question Menu

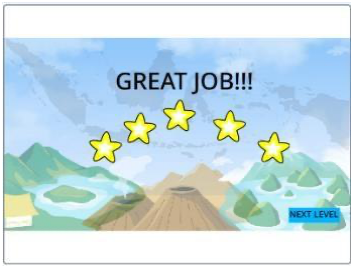


Image7 . Correct Answer Display

Image8 . Game Access

Figure 3. The initial design of the Culturepelago tread game.

2) *Design*

After the analysis stage, the initial design of the Tapak Nusantara game was carried out. At this stage, the game's flow was determined, the storyboard was developed, and the cultural elements of the culturepelago were incorporated into the game. In addition, an evaluation instrument consisting of an assessment rubric and *pretest* and *posttest* design was also designed to measure the game's effectiveness in improving children's critical thinking skills. The initial design of the culturepelago tread game is shown in Figure 3.

3) *Development*

In this third stage, the main goal is to develop a digital-based game prototype that was previously designed. This development process involves validators who are experts in their fields to ensure that the games produced fit the characteristics and needs of early childhood. Validators play an important role in providing input so that the game can meet relevant educational standards and effectively support children's development, especially in cognitive, motor, and social aspects. After completing the game prototype, it was tested on kindergarten B children from two schools with similar characteristics, namely IT Nada Ashobah and Labshool Unesa Kindergarten. These two schools were chosen because they have similarities in the characteristics of the children who will be the main target of the game. This trial aims to test the extent to which the game developed can be accepted and used well by children and identify shortcomings or areas that still need improvement before the game is applied more widely. This research examines the impact of using the Tapak Nusantara Game as a learning tool in early childhood. The main focus is to

evaluate various aspects that can improve the quality of learning, especially regarding critical thinking.

For dissemination, try the Tapak Nusantara Game for children. Before further discussion, the following important points will be outlined to provide a clearer picture of the methodology and results obtained.

b. Effectiveness of Tapak Nusantara Game in Improving Critical Thinking

Table 3. Result of paired samples test.

Paired Differences					t	df	Significance	
Mean			Std. Deviation	Std. Error Mean			One-Sided p	Two-Sided p
Pair 1	Pre_NadaAShobah - Post_NadaAshobah	-2.074	1.268	0.244	-8.494	26	0.000	0.000
Pair 2	Pre_Labschool - Post_Labschool	-1.038	0.915	0.179	-5.783	25	0.000	0.000

Based on the paired t-test results in Table 3, there was a significant difference between the pre-test and post-test scores in both the Nada Ashobah IT Kindergarten ($t = -8.494$, $p < 0.001$) and Labschool ($t = -5.783$, $p < 0.001$) groups. These results indicate that the game really impacts improving critical thinking in early childhood. Statistically, the average value of improvement (Ngain) of Nada Ashobah IT Kindergarten is higher than Labschool in the Scientific Competency and Problem Resolution aspects. This could be due to differences in learning methods used in each school and variations in children's digital experience. Children in IT Nada Ashobah Kindergarten are familiar with educational games, and there is teacher readiness to integrate games into the learning process. This finding is consistent with research showing that interactive technology-based media, such as educational games, can improve children's critical thinking skills from an early age. In addition, the constructivist learning theory developed by Piaget (1952) and Vygotsky (1978) also supports the idea that exploration and interaction-based learning can accelerate the development of critical thinking skills. Educational games allow children to develop problem-solving skills more naturally as they face challenges, encouraging them to think reflectively and analytically.

c. Comparison of Effectiveness in Two Schools

Table 4. Result of descriptive statistics.

N		Minimum	Maximum	Mean	Std. Deviation
NgainSC_NadaAshobah	27	0.000	0.670	0.3778	0.206
NgainPR_NadaAshobah	27	0.000	66.670	37.777	20.687
NgainSC_Labschool	26	0.000	0.500	0.182	0.162
NgainPR_Labschool	26	0.000	50.000	18.205	16.281
Valid N (listwise)	26				

From Table 4, the Nada Ashobah IT Kindergarten group had a higher mean Ngain than the Labschool Kindergarten. One reason for this difference is that the learning environment supports independent exploration and more active game interaction. The more significant standard deviation at Nada Ashobah IT Kindergarten suggests individual variation in critical thinking development. Differences may influence children's initial abilities before the intervention and

level of engagement in the game, where some children may be more responsive to the game than others. Digital native children are likelier to thrive in a game-based learning environment, especially when the approach is tailored to individual needs. Technology-based games can increase learning engagement, especially if the games are designed with elements appropriate for children's age and cognition. These findings indicate that game implementation strategies should be tailored to children's characteristics and readiness so that all participants benefit optimally.

d. Title

Gender_NadaAshobah		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Pre_NadaAShobah	L	0.427	14	0.000	0.631	14	0.000
	P	0.237	13	0.045	0.803	13	0.007
Post_NadaAshobah	L	0.357	14	0.000	0.772	14	0.002
	P	0.383	13	0.000	0.687	13	0.000
Pre_Labschool	L	0.349	16	0.000	0.716	16	0.000
	P	0.305	10	0.009	0.751	10	0.004
Post_Labschool	L	0.293	16	0.001	0.860	16	0.019
	P	0.254	10	0.067	0.833	10	0.036

e. Implications of Research Results

The results of this study have several implications for the world of education, especially in early childhood learning: The use of educational games such as Tapak Nusantara can be an effective alternative in stimulating critical thinking from an early age. Technology-based interactive games can improve critical thinking skills by 30% compared to conventional methods. Teachers and facilitators are very important in directing children so that games are not only played passively but are actually utilized as learning tools. The integration of games in the ECD curriculum can be done with a project-based learning approach so that children can relate the concepts in the game to real life.

Discussion

The development of digital technology has brought significant changes in various aspects of life, including early childhood education. Technology has become an effective learning medium, one of which is through a game-based learning approach (Aston, 2023b). This method is proven to be able to stimulate children's cognitive aspects, including critical thinking skills that play an important role in game analysis skills, including the ability to distinguish objects and characters and explain the relationship between these objects, inference skills involve the ability to predict the next step and determine solutions in facing game challenges, reflective thinking plays a role in evaluating decisions that have been made and conveying the reasons behind these decisions and these skills contribute to improving understanding and problem-solving in the context of the game. Game-based learning is an innovative approach that puts children at the center of learning (Pombo, 2023). Digital games in this method not only provide entertainment but also encourage children to think reflectively and logically. Previous studies have shown that educational games can improve critical thinking skills through fun and interactive learning experiences.

Tapak Nusantara game was developed as a form of innovation from the traditional crankle game adapted into a digital platform. This transformation was done to adapt to

the digital era and reintroduce traditional games to early childhood. This game is specifically designed to stimulate children's critical thinking by incorporating elements of Indonesian culture, such as traditional clothes, traditional houses, and regional food (Hartanto et al., 2021; Huang & Ng, 2021; Novikasari et al., 2024; Putri et al., 2024; Retnaningsih et al., 2024). The uniqueness of this game compared to other educational games lies in its game mechanism that combines cultural aspects with problem-solving strategies. Children play and learn to distinguish various cultural elements presented in an interesting visual and audio form (Cerezo et al., 2023). In this way, children will be more actively involved in learning. In this game, children are invited to complete tasks and challenges that have been designed to hone their critical thinking skills. Some of the activities in the game that stimulate critical thinking include analyzing cultural patterns, strategizing by distinguishing various cultural elements, and concluding and making decisions based on the patterns they have learned in the game (Tozduman & Güngör, 2020). Through this experience, children can develop critical thinking skills more effectively and enjoyably.

The tread culture game offers innovative media, supporting the development of critical thinking and preserving culture. Amid global media dominance, children today are more familiar with digital games based on foreign cultures than traditional Indonesian games. By incorporating elements of the culture of the country's culture in games, children can better recognize and appreciate the richness of their own culture in an interactive and fun way. With an approach that combines cultural exploration, critical thinking challenges, and experiential learning, this game proves that innovation in education can be done without abandoning the nation's cultural identity.

Pedagogical Implication: This research supports constructivist learning theories, which argue that children learn best through hands-on and interactive experiences. The implication for educational practices of the Tapak Nusantara game is that base learning should be incorporated into structured lesson plans to ensure it serves as a complementary learning tool rather than just entertainment. Educators should be trained to facilitate and guide gameplay to ensure children actively engage in critical thinking tasks rather than passively consuming content. Previous research has proven that digital-based games can improve children's critical thinking skills. However, few studies still specifically discuss how the integration of local cultural elements in educational games can contribute to the development of critical thinking in early childhood. Therefore, this research has the novelty of developing a local culture-based game that targets early childhood critical thinking skills, provides a more meaningful play experience by combining cognitive and cultural aspects in one game, and adapts learning methods to digital development and today's early childhood needs. Tapak Nusantara game is expected to be an innovative solution for improving children's critical thinking skills through a culture-based game-based learning approach. With an interactive and challenging learning environment, children can develop their critical thinking skills in a natural and fun way.

CONCLUSION

Fundamental Finding: The study highlights the effectiveness of Tapak Nusantara in enhancing critical thinking in early childhood. The Tapak Nusantara game, developed in this study, adapts the traditional crinkle game into a digital format while introducing local culture through engaging visuals and audio. In addition to providing a fun gaming experience, this game trains children in analyzing cultural patterns, strategizing, and making decisions. After playing this game, the results showed a significant increase in children's critical thinking, confirming that a game-based approach can be an innovative solution in early childhood education. This study used

the Research and Development (R&D) method with the 4D model (Define, Design, Develop, Disseminate). Data were collected through pre-test and post-test and analyzed using paired t-tests. The results showed significant differences between pre-test and post-test scores in the Nada Ashobah IT Kindergarten and Labschool groups, indicating the game's effectiveness in improving children's critical thinking. **Implication:** The Tapak Nusantara game can be a sustainable pedagogical approach fostering critical thinking in early childhood education; the study supports constructivist learning theory, emphasizing that children learn best through interactive experiences. A learning environment supporting children's exploration and active engagement also improves this skill. Thus, game-based learning designed according to children's developmental stage can be an effective and fun learning strategy. **Conclusion:** The study provides strong evidence that Tapak Nusantara can significantly enhance critical thinking skills in early childhood education while promoting cultural awareness. The findings suggest that games can be tools in modern pedagogy, especially in cultural contexts for early childhood.

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