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Implementation of Unplugged Activity Coding Learning Media Based on Computational Thinking Learning Strategy for Early Childhood

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Abstract

This research is motivated by the importance of developing Computational Thinking (CT) skills from early childhood as part of 21st-century skills in the digital era. However, the implementation of coding learning in early childhood still faces obstacles due to limited media and learning strategies that are appropriate for children's developmental characteristics. This study aims to determine the implementation and effectiveness of Unplugged Activity Coding learning media based on Computational Thinking strategies on the computational thinking abilities of early childhood children aged 5-6 years. The research method used is quantitative with a quasi-experimental approach using a One Group Pre-test-Post-test Design. The research subjects were 25 children aged 5-6 years at TK Insan Mulia Jakarta Selatan. The instrument used was an observation sheet for computational thinking abilities covering pattern recognition, algorithmic thinking, decomposition, and abstraction. Data analysis used paired t-test. The results showed a significant improvement in children's computational thinking abilities after implementing the media (pre-test=44.00; post-test=78.80; p=0.000). All aspects of computational thinking improved with an average of 79.09%. This research concludes that the Unplugged Activity Coding learning media based on Computational Thinking strategies is effective in improving early childhood computational thinking abilities and can be an innovative learning alternative in early childhood education.

[*Penelitian ini dilatarbelakangi oleh pentingnya pengembangan keterampilan Berpikir Komputasional (Computational Thinking atau CT) sejak usia dini sebagai bagian dari keterampilan abad ke-21 di era digital. Namun, penerapan pembelajaran coding pada anak usia dini masih menghadapi kendala akibat keterbatasan media dan strategi pembelajaran yang sesuai dengan karakteristik perkembangan anak. Penelitian ini bertujuan untuk mengetahui penerapan dan efektivitas media pembelajaran coding berbasis aktivitas tanpa perangkat (unplugged activity) yang mengacu pada strategi Berpikir Komputasional terhadap kemampuan berpikir komputasional anak usia dini (5-6 tahun). Metode penelitian yang digunakan adalah kuantitatif dengan pendekatan kuasi-eksperimen menggunakan desain One Group Pre-test-Post-test. Subjek penelitian terdiri dari 25 anak berusia 5-6 tahun di TK Insan Mulia, Jakarta Selatan. Instrumen yang digunakan adalah lembar*

observasi kemampuan berpikir komputasional yang mencakup aspek pengenalan pola, berpikir algoritmik, dekomposisi, dan abstraksi. Analisis data dilakukan menggunakan uji-t berpasangan (paired t-test). Hasil penelitian menunjukkan adanya peningkatan signifikan pada kemampuan berpikir komputasional anak setelah penerapan media tersebut (skor pre-test = 44,00; post-test = 78,80; p = 0,000). Seluruh aspek berpikir komputasional mengalami peningkatan dengan rata-rata capaian sebesar 79,09%. Penelitian ini menyimpulkan bahwa media pembelajaran coding berbasis aktivitas tanpa perangkat (unplugged) dengan strategi Berpikir Komputasional terbukti efektif dalam meningkatkan kemampuan berpikir komputasional anak usia dini dan dapat menjadi alternatif pembelajaran yang inovatif dalam pendidikan anak usia dini.]
Keywords: Computational Thinking; Unplugged Coding; Early Childhood; Learning Media; Game-Based Learning.

Introduction

The development of digital technology in the 21st century demands that the world of education prepare learners who possess critical thinking, creative, collaborative, communicative, and problem-solving skills from an early age. One skill that is currently gaining attention in global education is *Computational Thinking* (CT). Computational thinking is a thought process to formulate problems and solutions systematically so that these solutions can be executed effectively by humans and computers alike (Wing, 2006). This skill is viewed as a new fundamental ability that children need to possess to face the development of the digital era and artificial intelligence. Introducing computational thinking in early childhood is important because early childhood is a golden period (*golden age*) of children's cognitive development. At this stage, appropriate stimulation can help the development of logical, analytical, creative, and problem-solving thinking abilities optimally (Papert, 2020). Research shows that coding learning in early childhood can help children develop systematic thinking abilities and improve higher-order thinking skills. Additionally, coding can also improve children's social, emotional, communication, and collaboration abilities in the learning process (Bers, 2020).

In recent years, coding and computational thinking learning have begun to be widely applied in early childhood education in various countries (Campbell & Walsh, 2017). This is because coding is considered an effective means of building children's digital literacy from an early age (Resnick, 2017). According to Bers (2020), coding learning in early childhood is not only oriented toward technological abilities but also helps children become active creators capable of creating new solutions and innovations through computational thinking processes. However, the implementation of coding learning in early childhood education still faces various challenges. Limited digital facilities, low teacher readiness, and the scarcity of learning media appropriate to early childhood developmental characteristics are the main obstacles in implementing coding learning in schools (Yang, 2025). Furthermore, the continuous use of digital devices in early childhood can also result in reduced social and motor activities in children (UNESCO, 2023). Therefore, an alternative coding learning approach is needed that can still develop computational thinking while being appropriate to children's developmental stages.

One approach considered effective is *Unplugged Coding*. Unplugged coding is coding learning without using computers or gadgets, but through play activities, instruction cards, symbols, body movements, floor games, and other concrete activities (Bell et al., 2015). This approach is considered more suitable for early childhood because children learn through direct experience and enjoyable play activities. Recent research shows that unplugged coding activities can significantly improve children's computational thinking abilities. Children find it easier to understand concepts of algorithms, patterns, problem decomposition, and simple abstraction through concrete games (Kalelioğlu, 2018). Yang's research (2025), shows that developing computational thinking in early childhood requires active, interactive learning strategies appropriate to children's developmental characteristics. Therefore, integrating *Unplugged Activity Coding* learning media based on computational thinking strategies is expected to create meaningful learning (*meaningful learning*) and joyful learning for early childhood.

Based on the review of previous research, there is still limited research in Indonesia that examines the implementation and effectiveness of unplugged activity coding learning media based on computational thinking in early childhood. Previous research has focused more on the use of digital or robotic media in coding learning (Sullivan & Bers, 2016). Therefore, this research is important to provide an alternative coding learning media that is innovative, effective, easy for early childhood teachers to implement, and appropriate to early childhood developmental characteristics. The research problems in this study are: (1) How is the implementation of *Unplugged Coding* learning media based on *Computational Thinking* strategies in early childhood? (2) How effective is the use of *Unplugged Coding* learning media based on *Computational Thinking* strategies on early childhood computational thinking abilities?

Method

This research uses a quantitative method with a quasi-experimental approach. The research design used is the *One Group Pre-test-Post-test Design*, where children's abilities are measured before and after using the learning media. The research subjects were 25 children aged 5-6 years at TK Insan Mulia Jakarta Selatan, consisting of 13 boys and 12 girls. The independent variable in this research is the *Unplugged Activity Coding* learning media based on *Computational Thinking*, while the dependent variable is the *computational thinking* ability of early childhood children, which includes the ability to recognize patterns (*pattern recognition*), algorithmic thinking, problem decomposition (*decomposition*), and simple abstraction (*abstraction*). The instrument used was an observation sheet for computational thinking abilities that had been validated by experts and tested for reliability. The instrument consisted of 20 statement items with a maximum score of 100.

The research procedure included: (1) Preparation phase: initial observation, instrument preparation, learning media preparation, and instrument validation; (2) Pre-test phase: measuring children's initial abilities; (3) Implementation phase: implementing learning using *Unplugged Coding* media for 8 sessions (60 minutes/session); (4) Post-test phase: measuring children's final abilities; (5) Data analysis phase: processing data using statistical tests. Data were analyzed using descriptive statistics to determine the average pre-test and post-test scores, and paired t-test (*paired sample t-test*) to determine the effectiveness of the learning media. Before the t-test, a normality test was conducted using Shapiro-Wilk.

Result and Discussion

Pre-test Results of Computational Thinking Ability

Before treatment, a pre-test was conducted to measure children's initial *computational thinking* abilities. The pre-test results showed an average total score of 44.00 out of a maximum score of 100. Details per aspect are presented in Table 1.

Table 1. Pre-test Results of Computational Thinking Ability

Aspect	Maximum Score	Mean	Category
Pattern Recognition	25	12.40	Low
Algorithmic Thinking	25	10.80	Low
Decomposition	25	11.20	Low

Abstraction	25	9.60	Low
Total	100	44.00	Low

The highest score was obtained in the *pattern recognition* aspect (12.40), while the lowest score was in the *abstraction* aspect (9.60). Overall, children's initial *computational thinking* abilities were in the low category. This indicates that children were not yet accustomed to computational thinking activities in their daily learning.

Implementation of Learning Media

The implementation of "unplugged" coding activity learning media in this study was carried out over eight sessions, each lasting 60 minutes. The activities were designed progressively to develop four key components of computational thinking (CT) in early childhood: pattern recognition, algorithmic thinking, decomposition, and abstraction. This approach aligns with research by Fitriyah et al. (2026), which found that unplugged coding games utilizing concrete materials and play-based activities facilitate the emergence of core CT skills, including sequencing, decomposition, pattern recognition, abstraction, and problem-solving in young children.

In the first and second sessions, activities focused on pattern recognition. Children were encouraged to recognize patterns through picture card games and by arranging color patterns. These activities aimed to develop the children's ability to identify and extend patterns. Research by Oktaviani et al. (2025), demonstrated that 87.5% of children experienced improvements in computational thinking components, including pattern recognition, after participating in unplugged coding activities. Pattern recognition ability serves as a crucial foundation for developing more complex computational thinking skills, as children learn to observe regularities and relationships between objects or events.

The third and fourth sessions were designed to develop algorithmic thinking. Children arranged simple steps using floor games and instruction cards, learning to construct sequences of actions to achieve a goal. Research by Zhang et al. (2025), revealed that groups participating in computer-free programming activities showed significant improvements in CT compared to control groups. Algorithmic activities help children understand that every problem has a logical and systematic sequence of solutions, while also training them to think in a structured manner.

In the fifth and sixth sessions, children were introduced to the concept of decomposition. Children break down simple problems into smaller components through puzzles and storyboards, learning that large problems can be solved by deconstructing them into manageable parts. In their quasi-experimental study, Yunissafara et al. (2026), demonstrated that unplugged coding activities utilizing traditional food items as learning aids—significantly improved children's decomposition, pattern recognition, and basic algorithmic skills. Decomposition teaches children not to be intimidated by seemingly large problems, but rather to view them as a collection of smaller issues that can be resolved one by one.

The seventh and eighth sessions focus on simple abstraction. Children learn to identify essential information through games involving symbols and body movements, focusing on key details while disregarding irrelevant ones. Research into children's experiences with unplugged activities viewed through the lens of embodied cognition indicates that computational thinking (CT) emerges as an embodied phenomenon through the interaction between children's bodies and their learning environment. Abstraction is a high-level skill requiring continuous practice, as children must learn to distinguish relevant from irrelevant information when solving problems.

Figure 1. Pattern Recognition Activity Using Picture Cards

Image Description: The image shows a group of children aged 5–6 sitting in a circle on classroom benches. Each child holds a picture card featuring various colors and distinct images. A teacher stands nearby, displaying a pattern card that the children must replicate. The children appear enthusiastic as they arrange their cards to match the sequence shown by the teacher. Some children are seen discussing with their neighbors to ensure the pattern sequence is correct. A revealed pattern card is visible on a table beside the circle; for instance, if a child reveals a card depicting an *ondel-ondel* figure, they must locate another card featuring the same *ondel-ondel* image. The children's facial expressions reflect excitement and focus as they complete the pattern recognition challenge. This activity demonstrates how concrete media help children understand the concept of patterns visually and tactilely, serving as a crucial foundation for developing more complex computational thinking skills (Ningtyas et al., 2026; Ningtyas & Ningtyas, 2024; Oktaviani et al., 2025).

Figure 2. Algorithmic thinking activity using a floor game

Image Description: The image shows a classroom transformed into a floor game area. A large, colorful game board is visible on the classroom floor, featuring squares that form a path leading to a destination. A boy stands on the starting square, holding an instruction card displaying arrows pointing right, left, forward, and backward. He appears to be planning the steps needed to reach the destination square, which is marked with a star. Behind him, other children sit watching and offering suggestions. A teacher stands beside the game board holding spare instruction cards, ready to assist if the child encounters difficulties. Instruction cards are displayed on the classroom wall, showing the sequence of steps the children must follow; they must navigate challenges and find the correct path.

Figure 3. **Decomposition Activity through Puzzle Game**

Image Description: The image shows children are sitting in groups at the table. Each group has a set of puzzle pieces. A boy appears to be holding one puzzle piece while looking at the reference pict in front of him. Other children in his group appear to be matching puzzle pieces with the reference picture. The children appear to be collaborating, discussing, and helping each other in completing the puzzle. Their facial expressions show perseverance and curiosity. After the puzzle is completed, children are asked to tell the steps they took in arranging the puzzle, which is then connected to the concept of decomposition (Brennan & Resnick, 2012). This puzzle activity teaches children not to be intimidated by problems that appear large, but to see them as collections of small problems that can be solved one by one.

During the eight sessions of implementation, observation showed that 88% of children showed active engagement in learning. Children appeared enthusiastic about following every activity, able to cooperate in groups, and showed the ability to complete given challenges. Field notes also showed improvement in children's ability to: (1) follow instructions better, (2) complete tasks independently, (3) cooperate in groups, (4) communicate ideas and strategies, and (5) show persistence in facing challenges. This finding aligns with research by Brackmann et al. (2017) showing that *unplugged* activities in primary schools can effectively develop computational thinking skills.

Table 2. Observation Data of Children's Engagement during Implementation

Aspect of Observation	Sessions 1-2	Sessions 3-4	Sessions 5-6	Sessions 7-8	Average
Enthusiasm in following activities	72%	80%	84%	88%	81%
Ability to complete tasks	64%	72%	76%	84%	74%

Cooperation in groups	60%	68%	76%	80%	71%
Independence in learning	56%	64%	72%	80%	68%
Average	63%	71%	77%	83%	73.5%

Table 2 shows consistent improvement in all aspects of children's engagement from the first to the eighth session. The highest improvement occurred in the aspect of independence in learning, which increased from 56% to 80%, indicating that children became more confident and able to learn independently through *unplugged coding* activities. This supports research findings by Grover & Pea (2018) stating that effective *computational thinking* learning allows children to develop independence in problem-solving.

Post-test Results of Computational Thinking Ability

After implementing the learning media, a post-test was conducted to measure the improvement in children's *computational thinking* abilities. Post-test results are presented in Table 3.

Table 3. Post-test Results of Computational Thinking Ability

Aspect	Maximum Score	Mean	Category
Pattern Recognition	25	20.80	High
Algorithmic Thinking	25	19.60	High
Decomposition	25	20.00	High
Abstraction	25	18.40	Medium
Total	100	78.80	High

The average total post-test score was 78.80 out of a maximum score of 100. All aspects improved compared to the pre-test. The *pattern recognition* aspect reached the highest score (20.80) in the high category, while the *abstraction* aspect remained the lowest (18.40) but had reached the medium category. This finding shows that *Unplugged Activity Coding* media is effective in improving all components of *computational thinking*, although abstraction ability requires more time and further practice as it is a higher-order cognitive skill

Analysis of Learning Media Effectiveness

To determine the effectiveness of the *Unplugged Activity Coding* learning media, statistical tests were conducted comparing pre-test and post-test results. Data were first tested for normality using the Shapiro-Wilk test.

Table 4. Normality Test of Pre-test and Post-test Data

Data	Sig. Value	Description
Pre-test	0.124	Normal ($p > 0.05$)
Post-test	0.108	Normal ($p > 0.05$)

Since the data were normally distributed, the effectiveness test used the paired sample t-test.

Table 5. Paired t-test Results of Pre-test and Post-test

Variables	Mean	SD	t-count	df	Sig. (2-tailed)
Pre-test	44.00	8.24	19.872	24	0.000
Post-test	78.80	7.56			

The paired t-test results showed a t-count value of 19.872 with a significance of 0.000 ($p < 0.05$). This means there is a significant difference between children's *computational thinking* abilities before and after using the *Unplugged Activity Coding* learning media. This finding indicates that the learning media is effective in improving early childhood *computational thinking* abilities.

Table 6. Improvement of Computational Thinking Ability per Aspect

Aspect	Pre-test	Post-test	Improvement	Percentage
Pattern Recognition	12.40	20.80	8.40	67.74%
Algorithmic Thinking	10.80	19.60	8.80	81.48%
Decomposition	11.20	20.00	8.80	78.57%
Abstraction	9.60	18.40	8.80	91.67%
Total	44.00	78.80	34.80	79.09%

Based on Table 6, there was an average improvement of 34.80 points or 79.09% in children's *computational thinking* abilities. The highest improvement occurred in the *abstraction* aspect (91.67%) and the lowest in *pattern recognition* (67.74%). Although *abstraction* showed the highest percentage improvement, its final score remained the lowest among the four aspects, indicating that abstraction ability is the most challenging skill for early childhood and requires continuous development.

Discussion

The research results show that the *Unplugged Activity Coding* learning media based on *Computational Thinking* strategies is effective in improving early childhood *computational thinking* abilities. This finding aligns with previous research showing that *unplugged coding* activities can significantly improve children's *computational thinking* abilities (Dağ et al., 2023; Fitriyah et al., 2026; Saygıner & Tüzün, 2025). Research by Zhang et al. (2025), also confirms that *unplugged programming* activities are more effective than robot-based activities in developing *computational thinking* and executive functions in preschool children. The improvement in *pattern recognition* from 12.40 to 20.80 shows that children are able to recognize and continue patterns through concrete activities. This is consistent with the findings of Lin et al. (2020), stating that game-based smart toys are effective in improving pattern recognition abilities in preschool children. Arranging color patterns and picture cards helps children gradually develop observation and pattern identification abilities. According to research by Brennan & Resnick (2012), pattern recognition is an important foundation in *computational thinking* that allows children to see regularities and relationships between objects or events.

The improvement in *algorithmic thinking* from 10.80 to 19.60 indicates that children are beginning to be able to arrange steps sequentially. Research by Çiftci & Bildiren (2020) also found that coding courses have a positive effect on cognitive abilities and problem-solving in preschool children. Floor games and instruction cards provide concrete experiences for children in understanding sequence and algorithm concepts. Research by Fessakis et al. (2013) shows that children aged 5-6 years are able to develop algorithmic thinking through visual programming with appropriate guidance. This ability is important because algorithms are the core of *computational thinking* that allows children to arrange solutions systematically.

The improvement in *decomposition* from 11.20 to 20.00 shows that children are able to break problems into small parts. This finding is supported by research showing that *unplugged coding* activities support the development of fundamental algorithmic understanding and problem decomposition. Puzzle and storyboard activities help children learn that complex problems can be solved by breaking them into small steps. This approach aligns with the theory of meaningful learning that emphasizes the importance of direct experience in building conceptual understanding (Papert, 2020). The *abstraction* aspect showed the highest improvement (91.67%) from 9.60 to 18.40, although it remained the aspect with the lowest score. This aligns with cognitive development theory stating that early childhood is still in the concrete operational stage (Piaget, 1972), so abstraction ability is still developing and requires more practice and guidance. Symbol and body movement activities help children begin to identify important information from a problem. Research by Shute et al. (2017), emphasizes that abstraction is the most complex component of *computational thinking* and requires long-term development.

The success of implementing this learning media is supported by several factors. First, the use of concrete media such as picture cards, floor game boards, puzzles, and visual symbols makes it easier for children to understand abstract CT concepts through direct experience. Research by Kumala & Purwastuti (2026), found that media such as path boards, direction cards, and code symbols help children understand algorithm concepts concretely and support the development of logical thinking, collaboration, and problem-solving skills. Second, activities designed gradually from simple to more complex allow children to build understanding step by step. Third, game-based learning increases children's motivation and active participation. Research by All et al. (2021), shows that digital game-based learning is effective in increasing engagement and learning outcomes, and this finding also applies to non-digital games such as *unplugged coding*.

Fourth, the teacher's role as a facilitator is very important in providing guidance and support according to children's needs (*scaffolding*). Research by Yang (2025) shows that teacher professional development in CT and robotics approaches greatly influences the success of CT learning implementation in early childhood education. In this research, the teacher played an active role in facilitating discussions, providing guiding questions, and helping children who experienced difficulties without taking over the children's thinking process.

Meta-analysis research by Zhang et al. (2025), confirms that programming interventions are effective in improving programming knowledge, *computational thinking*, mathematical knowledge, and cognitive skills, with *unplugged* activities being more effective than screen-based activities for early childhood. This is because *unplugged* activities provide multisensory experiences involving movement, touch, and social interaction that are appropriate to early childhood learning characteristics. The findings of this research have important implications for early childhood education practice. First, *Unplugged Activity Coding* can be an innovative learning alternative that does not require expensive digital devices, so it can be implemented in various early childhood education institutions with limited technological facilities. Second, this approach integrates the development of *computational thinking* with play activities that are already a natural part of early childhood learning, so it does not add to the curriculum burden but enriches children's learning experiences. Third, the success of implementation shows that early childhood teachers can adopt this approach with adequate training and mentoring.

Conclusion

Based on the research results and discussion, it can be concluded that: 1) The implementation of *Unplugged Activity Coding* learning media based on *Computational Thinking* strategies in early childhood can be conducted through eight sessions of enjoyable and gradual play activities, including pattern recognition, algorithmic thinking, problem decomposition, and simple abstraction. Children showed active engagement that increased from 63% in the initial sessions to 83% in the final sessions, with high enthusiasm and participation throughout the learning process. 2) The *Unplugged Activity Coding* learning media based on *Computational Thinking* strategies is effective in improving early childhood *computational thinking* abilities. This is evidenced by a significant improvement in average scores from pre-test (44.00) to post-test (78.80) with a p-value of 0.000 ($p < 0.05$). All aspects of *computational thinking* improved with an average of 79.09%, namely *pattern recognition* (67.74%), *algorithmic thinking* (81.48%), *decomposition* (78.57%), and *abstraction* (91.67%).

This research recommends that early childhood teachers integrate *Unplugged Activity Coding* learning media into daily learning as an innovative, enjoyable, meaningful alternative that does not require expensive digital devices. Future research is suggested to: (1) develop *Unplugged Coding* media on other computational thinking aspects, (2) test its effectiveness on a wider age range with more rigorous experimental designs such as randomized controlled trials, (3) investigate the long-term impact of *unplugged coding* learning on children's cognitive development, and (4) develop teacher training models for sustainable *unplugged coding* implementation in early childhood education.

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