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Teacher's Perspectives on Young Children's Computational Thinking Skills through Unplugged Coding Activities, A Case Study of Children Aged 5-6 Years

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ABSTRACT
This study explores the development of computational thinking (CT) skills in early childhood through unplugged coding activities, focusing on the perspectives of teachers as observers and facilitators. Using an assessment instrument centered on four core CT components such as decomposition, algorithmic thinking, pattern recognition, and abstraction, the research was conducted with children aged 5–6 years engaging in a fruit skewer-making activity. The results demonstrate a strong alignment between assessment findings and teacher observations. Children showed progress in following procedural steps, recognizing and replicating patterns, breaking down tasks, and abstracting essential information. Teachers reported increased motivation, confidence, and problem-solving abilities among the children. These findings emphasize the importance of integrating unplugged coding into early childhood curricula and highlight the crucial role of teachers in creating supportive learning environments. The study suggests that teacher insights are essential for bridging theory and practice in CT education and recommends institutional support for resources and training to sustain effective implementation.

Keywords: Computational Thinking, Unplugged Coding, Teacher Perspectives, Pattern Recognition, Early Childhood Education

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1. INTRODUCTION

In the contemporary digital era, significant advancements in the domains of information and communication technology have precipitated substantial transformations across diverse facets of human existence (Wing, 2006). In the contemporary world, which is becoming increasingly complex and reliant on technology, the ability to think in a computational manner has become a critical competency. Computational thinking is defined as a cognitive process involving logical, systematic, creative, and critical thinking in problem-solving, as well as designing solutions that can be automated with the help of computer technology (Nouri et al., 2020; Wing, 2006)

Computational thinking (CT) is a set of problem-solving skills used to solve computational problems (Wing, 2006). Seymour Papert first proposed the idea in 1980 (Bull et al., 2020). CT is applied in many areas of daily life and should be taught to students at a young age (Denning, 2017). The importance of computational thinking skills for professionals in the technology field is well-documented. However, there is increasing recognition of these skills as fundamental competencies that should be imparted from an early age (Bers, 2019). It is expected that children who are introduced to computational thinking concepts at an early age will develop a strong foundation in problem-solving, adapting to change, and developing digital creativity in the future (Misirli and Komis, 2023). However, the integration and implementation of computational thinking in early childhood education continues to pose its own set of challenges, particularly in terms of pedagogical methodologies and assessment strategies (Bers, 2019).

It is widely recognized that children under the age of seven are in a period of rapid cognitive development. This stage is characterized by the significant potential for the stimulation of fundamental computational thinking skills. Consequently, there is a pressing need for innovative teaching methodologies that are tailored to align with the developmental stages of children, with the objective of optimally fostering critical thinking skills (Choiriyah et al., 2024). Jean Piaget's cognitive development theory states that period between the ages of 5 and 6 is considered a golden period in children's cognitive development and learning abilities. In this developmental stage, children begin to demonstrate increased rationality in their thought processes and acquire fundamental problem-solving abilities (He et al., 2021). Therefore, it is imperative to provide appropriate stimulation that aligns with children's developmental stages to successfully foster computational thinking skills from an early age (Acosta et al., 2024).

According to (Sundari & Choiriyah, 2022), ages 5 and 6 are crucial periods in children's cognitive development. At this stage, children begin to demonstrate increasingly complex language skills and continuously developing critical thinking abilities. In their research on the effectiveness of multimedia learning during the pandemic, (Choiriyah et al., 2022) emphasized that interactive, innovative learning methods are highly effective in enhancing critical thinking skills in young children. This suggests that appropriate learning approaches, whether digital or unplugged, can optimally stimulate computational thinking development in children

One widely recommended learning approach for young children is Unplugged Coding activities (Bell et al., 2009), Unplugged coding is a teaching method that introduces coding concepts through games, physical activities, and simple, engaging tools appropriate for children (Lee and Junho, 2019). These activities are expected to provide fun, effective learning experiences that foster computational thinking skills (Huang and Looi, 2020).

In early childhood education, teachers play strategic roles as facilitators and evaluators of children's developmental processes (Ulfadilah et al., 2023). Teacher assessments serve as tools to measure children's abilities and support and guide the learning process (Puspendik, 2015). However, research thoroughly examining how teachers assess young children's computational thinking skills, particularly through unplugged coding activities, remains limited (Relkin et al., 2020).

Early childhood education teachers frequently encounter challenges in articulating appropriate indicators of computational thinking skills for children's developmental levels (Clarke-Midura et al., 2021). The absence of standardized and contextual assessment guidelines engenders an assessment process that is suboptimal and fails to provide a comprehensive representation of actual development (Relkin et al., 2020). Consequently, research focusing on teachers' perspectives on the computational thinking skills of 5-6-year-old children through Unplugged Coding activities is imperative in order to develop an assessment model that is appropriate, applicable, and supports effective learning.

The findings of this study are expected to form the basis for recommendations for the development of an early childhood education curriculum that incorporates computational thinking through the Unplugged Coding method. The study is also expected to provide more structured and implementable assessment guidelines for teachers.

Computational Thinking Skills In Early Childhood: Unplugged Activities

Computational thinking is not thinking about computers or like computers because computers cannot think for themselves, at least not yet. By applying this way of thinking, the brain will be trained to get used to thinking logically, structurally, critically, and creatively (Andina, 2022) . Computational thinking has four main elements: decomposition, pattern recognition, abstraction, and algorithms (Biro Bebras, 2016). Decomposition is the process of breaking down a large problem into smaller parts so that it is easier to solve (Bebras, 2017). This problem-solving approach can be used when students plan an activity, work on a collaborative project, solve problems in mathematics, or even when performing a play (Yuliantina, 2024).

Abstraction is determining the important characteristics of a problem by discarding unimportant details (Bebras, 2017). Abstraction allows us to form a general idea of what the problem is and how to solve it (Bebras, 2021). The abstraction process instructs us to remove all specific details and patterns that will not help us solve a problem (Yuliantina, 2024). Pattern recognition is the search for or recognition of common patterns, both within and between problems, that we want to solve (Biro Bebras, 2016). Pattern recognition guides students to solve similar problems more quickly and easily (Bebras, 2021).

An algorithm is a step-by-step process problem-solving process (Biro Bebras, 2016). Algorithms are common in computer science and everyday life (Bebras, 2021).A recipe is one example of an algorithm that occurs in everyday life. These simple steps or rules are used to help solve complex problems in the best way possible (Yuliantina, 2024).

Is computational thinking only possible for students who use computers? The answer is definitely no (Yuliantina, 2024). Computational thinking is a set of skills and problem-solving processes that are conceptual in nature and can be learned independently of the computer device itself (Biro Bebras, 2016). In fact, this concept originates from how computers solve problems, but computational thinking is essentially the human ability to break down complex problems into simpler parts, create algorithms or systematic steps, and use logic to find solutions. This process is highly relevant and can be taught without relying on computer technology.

In early childhood education settings, the use of computers as a learning tool may not be optimal and is not always available. However, this is not an obstacle to developing children's computational thinking skills. In fact, with the right approach, children can learn computational thinking without having to interact directly with computers. This learning model is known as the unplugged approach or "computer-free" learning (Yuliantina, 2024).

In the unplugged approach, learning activities are designed using simple tools and media such as board games, puzzles, building blocks, and other interactive and fun activities. These activities explicitly teach computational thinking concepts, such as recognizing patterns, creating step-by-step sequences (algorithms), decision-making, and structured problem-solving (Mutoharoh et al., 2023). In this way, children learn to think logically and systematically through real-world activities appropriate for their age level.

The unplugged method in computational thinking for early childhood focuses on basic understanding. Without tools, children can focus on the basic concepts of computational thinking, such as pattern recognition, decomposition, and problem solving, without the distraction of technology. This helps them understand the core of computational thinking more deeply. Activities such as puzzles, role-playing games, and traditional games can stimulate problem-solving and logical thinking without the need for tools. For example, traditional games like hopscotch teach children about patterns and sequences without requiring electronic devices (Yuliantina, 2024).

Teachers' Perspectives On Computational Thinking Assessment

Assessing computational thinking skills in young children must take into account their developmental characteristics, so that assessment is more formative and observation-based (Denner et al., 2015). Teachers use criteria such as problem solving, logic, creativity, and collaboration to assess children's abilities during learning activities (Secolsky & Denison, 2017). Direct observation and documentation of children's work are the primary tools for assessing the development of computational thinking in children (Relkin et al., 2020).

Studies indicate that teachers play a crucial role in assessing and developing computational thinking skills in young children. Teachers need to have an understanding of concepts and appropriate tools so that assessments can accommodate individual differences in children's abilities (Terroba et al., 2022). However, challenges faced by teachers include time constraints, limited resources, and a lack of specialized training related to computational thinking assessment (Angeli and Giannakos, 2020).

2. METHOD

This study uses a qualitative research design with a case study approach. The case study approach was chosen to gain a deep understanding of how teachers assess the computational thinking abilities of 5-6-year-old children through unplugged coding activities in the context of a specific classroom. With this approach, the researcher can obtain a comprehensive and contextual picture of the assessment process carried out by teachers.

This research was conducted at Risanti I Kindergarten, located in the DPR RI Kemanggisan, West Jakarta. The selection of this location was based on several considerations that support the relevance and feasibility of the research. Risanti I Kindergarten is one of the early childhood education institutions that has begun to integrate the unplugged coding approach into daily thematic learning activities, especially in the form of games that stimulate logical thinking skills, arrange sequences, and recognize patterns.

Furthermore, one of the teachers at this institution has participated and completed a micro credential scholarship program in Computational Thinking organized by the Indonesian Ministry of Education. This shows strong pedagogical readiness and capacity in implementing and assessing activities related to the development of computational thinking skills in early childhood.

Data collection activities were carried out during December 2024, including direct observation of learning activities related to unplugged coding, in-depth interviews with teachers who acted as facilitators of the activities, and collection of supporting documents such as child development records, RPPH, and student work. All data was collected by paying attention to the principles of research ethics and confirmation of participation from the school.

The subjects in this study consist of two main groups, namely teachers and young children in one class at TK Risanti I in West Jakarta. Teachers were selected purposively based on criteria of experience teaching young children and direct involvement in unplugged coding activities. The children who participated in unplugged coding activities in the class were also part of the research subjects, where the researcher conducted observations to complement the data on the assessment of computational thinking skills conducted by teachers.

Research data was collected through several techniques, namely: In-depth interviews with teachers, aimed at exploring teachers' perspectives and understanding of assessing children's computational thinking skills. These interviews also explored the aspects being assessed, the challenges faced, and the assessment strategies implemented by teachers during and after the activities. Data was collected through participatory observation, where researchers directly observed unplugged coding activities in the classroom. This observation focused on the interaction between teachers and children during the activity, as well as how the assessment process was carried out in real-time. Documentation included the collection of supporting documents such as children's work, teacher notes, and assessment instruments used by teachers (if available). This documentation served as additional data to strengthen the analysis.

The instruments used in this study include a semi-structured interview guide, containing open-ended questions designed to explore the assessment process and criteria used by teachers in assessing children's computational thinking skills. The instruments also include an unplugged coding activity observation sheet, which is used to record participants' activities and teacher interventions during the activity. Another instrument is written documentation, consisting of field notes from the researcher and teacher assessment instruments.

Data obtained from interviews, observations, and documentation will be analyzed using thematic analysis. The analysis process includes: (1) Transcribing interview results and observation notes so that the data can be examined in detail. (2) Coding the data to identify the main themes related to teachers' perspectives on the computational thinking abilities of young children. (3) Interpreting and triangulating the data to ensure the validity of the findings by comparing and synthesizing data from various sources.

Through this methodology, it is hoped that the research can provide an in-depth picture of how teachers assess the computational thinking abilities of 5-6-year-old children in unplugged coding activities, as well as the factors that influence the assessment process.

Unplugged Coding Activities are learning activities that teach the basic concepts of computational thinking without using computers or digital technology. These activities are designed to introduce algorithmic thinking, problem decomposition, pattern recognition, and abstraction through concrete and simple activities, making them particularly suitable for young children.

In the fruit skewer-making activity, children are guided through a process closely tied to computational thinking concepts, namely:

a. Task Decomposition: Children break down the fruit skewer-making process into smaller steps: selecting fruits, cutting fruits, arranging fruits on skewers, and counting the number of fruits. This reflects the ability to break down a large problem into simpler parts.
b. Algorithm Sequencing: Children perform the steps in a specific order, following a structured procedure to make fruit skewers with a predetermined color pattern.
c. Pattern Recognition: The child recognizes the color pattern that must be arranged repeatedly on the skewer, identifies and applies the pattern consistently.
d. Abstraction: The child simplifies information, focusing on patterns and fruit counts without being distracted by details such as fruit size or specific types that are less relevant in the context of patterns and counting.

Since the entire process is done manually with real materials (fruits), without the aid of computers or electronic devices, this activity falls under Unplugged Coding Activities. This activity is highly effective for instilling the fundamentals of computational thinking in a visual and kinesthetic manner, making it suitable for introducing children to it in a fun and interactive learning setting.

3. RESULTS AND DISCUSSION

During computational thinking activities, children make fruit skewers. Teachers provide various types of colorful fruit, such as watermelon, grapes, melon, and dragon fruit. The children are instructed to cut the fruit into small pieces, which are then ready to be skewered. Teachers supervise the cutting process directly to ensure safety and orderliness. Then, they arrange the pieces onto the skewers in specific color patterns. They also count the number of pieces of fruit on each skewer. This activity develops computational thinking skills by applying systematic steps and recognizing patterns.

Figure 1. Making fruit skewers activity

Decompsition

Decomposition skills are an important part of computational thinking, involving the ability to break down complex problems or tasks into smaller, more manageable parts that can be solved step by step. In young children, this concept is nurtured through simple and meaningful practical activities, such as making fruit skewers. The Decomposition Process in Making Fruit Skewers:

1. Breaking Down the Main Task into Small Steps
   The activity of making fruit skewers naturally consists of several steps that must be followed to achieve the final goal. Children are taught that a big task like making fruit skewers does not have to be done all at once, but can be divided into several stages, namely: Selecting the variety of fruits to be used, Cutting the fruit into small pieces that can be skewered, Arranging the fruit pieces according to the desired color pattern, and Counting the number of fruits on each skewer.
2. Focusing on Each Stage Separately
   By breaking the task into smaller, more specific parts, children can focus better and understand each process in depth. For example, during the fruit-cutting stage, they learn basic cutting techniques and how to use cutting tools safely under the teacher's guidance. During the pattern-arranging stage, children can concentrate on the sequence of colors and shapes without rushing to the next stage.
3. Reduce Complexity with a Step-by-Step Approach
   Large tasks can seem daunting or complicated to young children. Through decomposition, these tasks become easier to digest and more enjoyable. Children learn that solving big problems can be done systematically by completing sub-tasks one by one.
4. Development of Organizational and Planning Skills
   By observing the entire process and breaking it down into several steps, children also begin to develop the ability to plan the sequence of activities to be performed. They learn to prepare materials such as fruits first, then cut, arrange, and finally count. This helps children understand the importance of procedures in completing a task.
5. The Role of Teachers in Guidance and Understanding
   Teachers play a crucial role in helping children understand the steps they must go through and ensuring that each step is done correctly. Guidance during the fruit-cutting process not only

ensures children's safety but also provides an opportunity to explain and demonstrate directly how a large task can be broken down and organized.

Algorithmic Thinking Ability

Algorithmic thinking is one of the fundamental pillars of computational thinking. It refers to the ability to follow and construct a procedure or a series of systematic, logical, and orderly steps to complete a task or solve a problem. In early childhood education, this ability is nurtured through simple, tangible, and easily comprehensible activities, such as making fruit skewers. The systematic sequence of steps involved in making fruit skewers includes:

1. Clear and Sequential Procedural Stages
   Children learn to follow tasks step-by-step in a specific order. This begins with selecting the available fruits, then cutting the fruit into small pieces suitable for skewering, arranging the pieces on a skewer following a pre-determined color pattern, and finally, counting the number of fruit pieces on each skewer.
2. Understanding the Sequence and Order of Steps
   An algorithm is essentially a sequence of instructions that must be followed in an orderly manner to achieve the desired outcome. Children begin to understand that skipping a step or disrupting the sequence may lead to an incorrect or undesirable result for example, the fruit skewer may not reflect the intended pattern or have the correct quantity of fruit.
3. Developing Cause-and-Effect Thinking
   By correctly executing an algorithm, children begin to perceive the causal relationships embedded within each step. For instance, they realize that the fruit must be cut first in order to be skewered properly; if the fruit is not cut, the skewering process cannot proceed effectively. This awareness strengthens sequential logic and critical thinking skills.
4. Fostering Precision and Consistency
   When creating color patterns on the fruit skewers, children are encouraged to consistently follow the established pattern. This process teaches them to be meticulous in executing each instruction and to recognize the importance of accuracy in every step of the algorithm to achieve the expected outcome.
5. Encouraging Creativity in Generating New Instructions
   After understanding the taught algorithm, children may experiment with creating their own patterns or "algorithms" in assembling the fruit skewers. This reflects their growing creativity and their emerging ability to construct simple, logical, and systematic algorithms.
6. The Role of the Teacher as Facilitator and Guide
   Teachers play a vital role in helping children understand and follow algorithmic steps by providing clear instructions and offering support when children experience confusion or make mistakes. Teachers may also pose reflective questions such as, "What should we do first?" or "What happens if we change the order?" to deepen the children's understanding of algorithmic concepts.

This approach illustrates how algorithmic thinking skills are introduced and cultivated in young children through engaging, hands-on, and contextually meaningful activities. Children do not merely learn to follow instructions; they also begin to internalize the concepts of logical and systematic sequencing, laying a strong foundation for the development of computational thinking.

Pattern Recognition Skills

Pattern recognition is a critical component of computational thinking, referring to the ability to identify, compare, and replicate specific sequences or arrangements of objects or information. Engaging in pattern recognition activities enables children to recognize order and structure within data they encounter, which can later be used to make predictions or solve problems. Implementation through the Activity of Making Fruit Skewers

1. Observing Color and Fruit Type Patterns
   Children observe and recognize patterns in the color and type of fruits to be arranged on the skewers. For example, they may identify recurring sequences such as watermelon, grape, melon, dragon fruit, watermelon, grape, and so on, or specific alternating patterns. This task requires children to pay attention to the sequence of both colors and fruit types.
2. Comparing Existing Patterns
   Children compare the patterns they observe with a sample or teacher-provided instructions to ensure that the arrangement of fruits on the skewer follows the correct pattern. This process sharpens their visual discrimination and attention to detail.
3. Replicating and Extending Patterns
   After recognizing a pattern, children attempt to replicate the arrangement on subsequent skewers and continue the pattern as desired. This trains their ability to remember and apply the pattern consistently.
4. Using Pattern Recognition to Solve Problems
   Pattern recognition goes beyond observation, it helps children solve problems in a systematic way. For instance, if a color sequence is interrupted, children can identify the missing element and correct it to achieve the intended result.
5. Developing Early Abstraction Skills
   By identifying concrete patterns in fruit arrangements, children begin to generalize the concept of a pattern as a repeatable sequence that can be applied in other contexts. This represents an early step toward abstraction, a key element of computational thinking.
6. The Role of the Teacher in Guiding and Directing
   Teachers can facilitate pattern recognition by providing clear examples and prompting reflective questions such as, "What would happen if we changed this sequence?" or "Can you create a new pattern using different fruits?" These strategies encourage children to explore further. Through this activity, children's pattern recognition skills are nurtured in an enjoyable and contextualized manner, serving as a foundational aspect of learning computational thinking.

Abstraction Skills

Abstraction is a mental process in which children learn to filter complex information and simplify it into core concepts that are easier to understand and apply in various contexts. Within computational thinking, abstraction enables children to focus on the most important aspects of a problem without being overwhelmed by irrelevant details. The Abstraction Process in the Fruit Skewer Activity

1. Simplifying the Activity into Core Concepts

Children learn not to focus on each individual fruit piece but to perceive the entire fruit skewer as a single unit composed of several fruit pieces. For example, when counting the number of fruits on a skewer, they understand that what matters is the total count rather than the individual characteristics of each piece, which helps them manage information more efficiently.

2. Understanding the Main Objective of the Activity
   With teacher guidance, children are directed to focus on the primary goal of the activity, creating a fruit skewer with a specific color pattern and counting the number of fruit pieces as a final result. They begin to generalize that such counting and patterning can be applied in other contexts, not limited to fruit-based tasks.
3. Disregarding Irrelevant Details
   For instance, details such as the specific type or exact size of the fruit are not the main focus when arranging color patterns or counting pieces. Through this process, children learn to identify and retain essential information while discarding less relevant data in their thinking process.
4. Generalizing Concepts to Other Situations
   Abstraction also enables children to transfer the patterns and counting strategies they have learned to new situations beyond making fruit skewers. For example, they may apply these concepts during play, in other learning activities, or in daily routines.
5. Developing Mental Representations
   As children learn to simplify and generalize concepts, they also develop abstract mental representations that support decision-making and problem-solving in the future.
6. The Role of the Teacher in Facilitating Abstraction
   Teachers play a crucial role in helping children see the bigger picture of the activities they are engaged in. By using age-appropriate language and guided questions such as "What are we counting now?" or "How can we apply this pattern to other kinds of food?", teachers support the development of abstract thinking in a simple and enjoyable way.

This explanation illustrates how abstraction skills begin to emerge in young children through contextualized and guided activities, serving as a vital foundation for understanding and applying computational thinking more broadly. This instrument is used to assess children's computational thinking abilities through the activity of making fruit skewers. The assessment is conducted through observation of the four main components: decomposition, algorithm, pattern recognition, and abstraction.

Table 1. Assessment Instrument for Children's Computational Thinking

No	Component	Assessment Indicators	Score (1–4)	Notes / Observation Examples
1	Decomposition Skills	a) The child is able to break down the task of making fruit skewers into smaller steps (choosing fruit, cutting, arranging, counting) b) The child cuts the fruit into small pieces with teacher guidance c) The child recognizes that arranging the fruit skewer is done in separate stages		Follows the steps in the correct sequence Cuts fruit according to requested size Arranges fruit one by one

2	Algorithm Skills	a) The child follows a systematic sequence of steps (cutting, arranging based on pattern, counting) b) The child can arrange fruits on the skewer following the given color pattern c) The child counts the number of fruit pieces on the skewer accurately	Performs steps correctly Arranges fruit according to pattern States correct number
3	Pattern Recognition Skills	a) The child identifies the color pattern of the fruit to be arranged b) The child is able to imitate and continue the pattern on the next skewer c) The child can correct the pattern if there is a mistake	Recognizes repeating colors Replicates pattern accurately Fixes incorrect arrangement
4	Abstraction Skills	a) The child can count the total number of fruits on a skewer without counting each piece one by one b) The child can explain the purpose of the fruit skewer activity involving patterns and counting c) The child can generalize the concept of pattern or counting to other activities	Quickly states total Explains importance of pattern and quantity Gives other examples

Scoring Guidelines

a) Score 1: Has not yet demonstrated the skill / does not understand the instruction
b) Score 2: Begins to demonstrate the skill with intensive guidance
c) Score 3: Demonstrates the skill with minimal guidance
d) Score 4: Demonstrates the skill independently and consistently

This instrument can be used by teachers as a guide for observing and assessing the development of children's computational thinking during the fruit skewer activity.

Teachers' Perspectives on Computational Thinking Skills in Early Childhood through Unplugged Coding Activities

This study aims to examine early childhood computational thinking (CT) skills through unplugged coding activities, as well as to explore teachers' perspectives as observers and facilitators of these activities. The assessment instrument used focuses on four key components of computational thinking: decomposition, algorithmic thinking, pattern recognition, and abstraction. The results from both children's assessments and teacher perspectives indicate a synergy in supporting the development of CT skills among children aged 5–6 years through the activity of making fruit skewers.

Teachers reported that the children demonstrated the ability to follow procedural steps in making the fruit skewers, aligning with the algorithmic thinking indicators in the assessment instrument. The children not only followed the sequence of instructions but were also capable of self-correcting errors, thereby enhancing the problem-solving skills inherently linked to algorithms. This finding reinforces (Wing, 2006) theory that computational thinking includes the ability to formulate and execute algorithms adaptively. The teachers' perspectives offer empirical confirmation that unplugged coding approaches allow children to internalize algorithmic concepts naturally and enjoyably.

The decomposition section of the instrument showed that children were able to break down the task of making fruit skewers into simple steps such as selecting fruit, cutting, arranging patterns, and counting. Teachers observed that this step-by-step approach made it easier for children to understand and complete the task, while also fostering confidence in managing structured activities. These findings align with (Andina, 2022), who highlight the benefits of decomposition in CT education, emphasizing that understanding smaller components enhances children's grasp of the overall process.

Assessment results revealed that children could recognize and replicate fruit color patterns effectively. Teachers added that children enjoyed engaging with these patterns and, through repeated activities, became increasingly adept at recognizing pattern differences and developing predictive abilities. This confirms that pattern recognition goes beyond memorization; it is a cognitive process involving analysis and synthesis of information, as described by (Lee and Junho, 2019).

Children demonstrated the ability to simplify information by focusing on essential aspects such as patterns and quantities, without becoming distracted by irrelevant details. Teachers confirmed that guidance and explanations provided during the activity helped children develop abstraction skills by clarifying the core concepts that needed to be understood. This aligns with (Denning, 2017) definition of abstraction in CT, in which filtering information to solve problems is a key element of higher-order thinking.

The combination of a systematic assessment instrument and teachers' insights as learning facilitators provides a comprehensive picture of children's CT development through unplugged coding activities. Teachers' perspectives serve as a vital link between theory and practice, ensuring that the implemented activities are both effective and developmentally appropriate. Therefore, integrating teacher input in learning evaluation becomes a crucial component in the implementation of CT-based learning approaches in early childhood education.

Teachers serve not only as supervisors but also as facilitators who guide and support children throughout the learning process. According to their perspectives, consistent and interactive guidance helps children gradually and joyfully understand CT concepts. The practical implication is the importance of adequate teacher training to enable them to create a conducive learning environment for unplugged coding activities and to recognize observable signs of CT development in children.

The assessment results obtained through a structured instrument were validated by teacher observations, indicating that the tool is both relevant and effective in measuring CT components such as algorithms, decomposition, patterns, and abstraction. A further implication is the need for continuous review and refinement of the instrument to ensure its suitability for early learning contexts and its alignment with current theoretical developments, thereby supporting comprehensive and in-depth evaluation.

Teachers also reported that children experienced increased motivation and self-confidence during the fruit skewer activity. This demonstrates that learning approaches involving physical, visual, and interactive elements (unplugged coding) are more effective than conventional abstract and passive methods. The implication of this finding is a recommendation to integrate more hands-on and contextual activities into early childhood curricula to support both psychosocial and cognitive development.

Teacher perspectives provide empirical insight that enriches existing CT theories within real classroom contexts. This implication is highly relevant for developing evidence-based learning practices. As practitioners and sources of qualitative data, teachers offer valuable input regarding the effectiveness of methods and the adaptation of instructional strategies to suit the needs and characteristics of children aged 5–6 years.

The combined findings from assessment data and teacher perspectives support the integration of unplugged coding into early childhood education curricula. The policy implication is the need for institutional support to provide resources, training, and learning materials that promote the systematic and enjoyable development of computational thinking. Furthermore, optimizing teacher involvement as key stakeholders is essential to ensure the effective and sustainable implementation of CT learning.

4. CONCLUSION

Based on the analysis of the assessment instrument and teachers' perspectives, it can be concluded that unplugged coding activities, specifically through the fruit skewer making task are effective in developing computational thinking skills in children aged 5–6 years. The children demonstrated progressive mastery of the key components: algorithmic thinking, decomposition, pattern recognition, and abstraction, in alignment with their cognitive development. Teacher guidance played a vital role in helping children understand computational thinking concepts and internalize the processes in an enjoyable and natural way. Furthermore, teacher perspectives provided empirical evidence that this method supports not only cognitive development but also enhances children's motivation and self-confidence in learning.

In light of these findings, it is recommended that teachers receive more intensive training in understanding computational thinking and implementing unplugged coding activities to effectively support children's learning. The assessment instruments must be designed systematically and comprehensively, and continuously refined to accurately and holistically map children's CT development. Unplugged coding activities, such as making fruit skewers, should be integrated regularly into early childhood education curricula to support the development of 21st-century skills. Involving parents' perspectives in future research may offer broader insights into the impact of these activities within the home learning context. Additionally, the development of varied, engaging, and relevant unplugged coding activities is necessary to keep children motivated and to provide diverse experiences in computational thinking

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