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# Development of Learning Strategies to Integrate Computational Thinking in Early Childhood Education Curriculum: A Study on 36 Early Childhood Education Units in Kudus

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**ABSTRACT:**
Indonesia's low achievement in international assessments such as PISA shows the need to strengthen high-level thinking skills from an early age. One of the important competencies of the 21st century is computational thinking, which is a logical and systematic framework of thinking in solving problems. This research aims to develop a learning strategy to integrate computational thinking skills into the Early Childhood Education (PAUD) curriculum. The research was carried out in 36 partner PAUD units in Kudus Regency, Central Java, using the Research and Development (R&D) approach with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model. The research subjects consisted of school principals and PAUD teachers. The development process lasted for eight months, starting with training related to the concept of computational thinking, its relationship with the Independent Curriculum, and its implementation strategy in classroom learning. The results of the study show that teachers need clear and practical guidance to integrate computational thinking skills into learning activities that are in line with the Independent Curriculum. This research does not produce a new curriculum product physically, but gives birth to a model of learning strategies that are conceptual and implementive. The strategy includes steps to prepare a plan, organize the play environment, and provide teacher support that encourages children's computational thinking skills. Implementation in the field showed a positive impact on teacher understanding, child involvement, and parental response, although challenges were still found in a small number of PAUD units. This research makes a concrete contribution to strengthening adaptive and future-oriented PAUD learning practices.

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## 1. Introduction

The results of the Programme for International Student Assessment (PISA) in 2022 show that Indonesian students' achievements in mathematics, reading, and science are still below the average of OECD countries (OECD, 2022). As many as 51% of Indonesian students who take PISA are 15 years old and enrolled in grade 10, and the report shows that 85% of them have attended pre-primary education for one year or less below the OECD average of 94%. PISA data also show that children's participation in pre-school education has a positive correlation with academic achievement at age 15, even after adjusting for socio-economic factors and other contextual factors (Tonga et al., 2022).

These findings indicate the importance of building a strong foundation of thinking skills from an early age. Efforts to improve students' ability to solve complex problems, think critically, and communicate effectively need to start by strengthening teachers' capacity in fostering children's basic cognitive competencies from the early childhood education level. One relevant approach to achieving this goal is computational thinking, which is a systematic and logical way of thinking to understand, formulate, and solve problems efficiently. This ability is now recognized as one of the lifelong skills that are important to face the challenges of the 21st century. Jeannette Wing even states that it is almost impossible to conduct research in a discipline or field of engineering without computational thinking skills, and emphasizes that anyone regardless of their profession will benefit from mastering these skills(Masarwa et al., 2024) .

Computational thinking is not solely related to the use of computers, but rather about solving problems through logical, structured, critical, and creative thinking processes (Krauss & Prottsman, 2016). In the context of early childhood education, these abilities can be developed without relying on digital technology devices. The OECD in one of its publications also mentions that computational thinking can be introduced from childhood, in line with the development of basic literacy and numeracy (Portelance & Bers, 2015).

However, the results of initial observations in the field show that PAUD teachers' understanding of the concept of computational thinking is still low. Many teachers consider it as a separate subject that is not related to other aspects of child development, so it is difficult to apply it in the daily learning process. This condition causes teachers to not be able to integrate computational thinking skills into learning activities that are in line with the Merdeka Curriculum (Islamiyah, 2022).

To answer these challenges, this research aims to develop a learning strategy that allows the integration of computational thinking into the applicable PAUD curriculum, namely the Independent Curriculum. The strategies developed include how to design learning planning, organize the play environment, and provide learning support that encourages the emergence of computational thinking skills in children. The development process is carried out using the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model, which is considered systematic, simple, and applicable for the development of learning strategies at the early childhood education level.

The curriculum is very important to ensure quality learning in accordance with the goals to be achieved by both the state and the educational unit. Curriculum development needs to be continuously carried out to suit the demands of the current times. The current curriculum needs to be developed to accommodate children's needs and interests and ensure that the learning objectives set are achieved. This is in line with the statement of ( Ornstein & Hunkins., 2021) who stated that the curriculum is a series of planned experiences that are compiled by schools to help students achieve educational goals (Tymkiv, 2018).

The curriculum is a set of plans and arrangements concerning the objectives, content, learning materials, and methods used as guidelines for implementing learning activities. In the context of Early Childhood Education (ECE), the curriculum is designed to stimulate all aspects of child development holistically—physical, cognitive, linguistic, social-emotional, and moral. The development of the ECE curriculum is based on several key principles, including learning through play as the natural way children learn, hands-on experiential learning to strengthen sensory and motor understanding, and a holistic approach that encompasses all developmental domains. The curriculum must also incorporate a differential approach to accommodate individual needs, engage parents and the community as strategic partners, provide a safe and healthy environment, and employ ongoing, authentic, and comprehensive evaluation. According to the National Association for the Education of Young Children (Mechler, 2020; Nerren, 2020; Turner & Turner, 2023), a high-quality curriculum is one that is written, flexible, culturally and linguistically responsive, and promotes continuity across ages and educational levels. Additionally, the curriculum should align with national learning standards and allow room for adaptation based on children's interests and experiences.

Computational thinking is a systematic approach to understanding and solving problems through a sequence of logical processes, including decomposition, abstraction, algorithmic thinking, and evaluation. According to Wing (Al-qassar et al., 2021), computational thinking is a fundamental and essential 21st-century skill that applies across all fields of science. She emphasized that it should not be seen merely as a skill for computer programming, but as a core competency relevant to any human activity that involves analytical thinking. Computational thinking empowers individuals—including young children—to recognize and make sense of complex problems, develop efficient and suitable solutions, and train their minds to think logically, in a structured manner, as well as critically and creatively. This cognitive approach helps lay the foundation for lifelong problem-solving abilities and innovative thinking.

In the context of early childhood education, computational thinking is not synonymous with the use of digital devices. Instead, young children can develop these skills through engaging play activities, exploring patterns, solving problems, and participating in collaborative projects, all without the need for a computer. This method is often referred to as the "unplugged approach," which emphasizes the development of thinking skills through hands-on and experiential learning. According to the OECD (2022), computational thinking can be introduced from an early age and can evolve alongside children's basic literacy and numeracy skills. The key components of computational thinking that are particularly relevant for early childhood include decomposition, abstraction, pattern recognition, and algorithms. Decomposition involves breaking down complex tasks into smaller, manageable parts, such as sequencing steps in a daily routine or dividing a story into different scenes. Abstraction helps children focus on essential information while ignoring irrelevant details, allowing them to simplify problems more effectively. Pattern recognition enables them to identify similarities across different situations, supporting the reuse of familiar solutions. Meanwhile, algorithmic thinking encourages the creation of structured, step-by-step processes to complete a task, such as washing hands, arranging blocks, or following a simple recipe. These elements collectively nurture logical, structured, and creative thinking from an early age, laying a strong foundation for lifelong problem-solving and innovation.

Various previous studies have shown that computational thinking is a vital competency that can be introduced from an early age. Voogt et al. (2015) emphasize that computational thinking is a universal skill that should be instilled in children as part of their analytical ability. Similarly, Kazakoff and Bers (2012) describe it as the capacity to think logically, utilize algorithms, solve problems, and acquire basic programming skills. Building on this, Bers et al. (2014) argue that early childhood educators and pre-service teachers must possess both conceptual and pedagogical understanding of computational thinking before they can design effective and meaningful learning experiences for young children. Other studies, such as those by Papadakis et al. (2018) and Angeli & Valanides (2020), highlight the role of play-based learning, especially through child-parent collaboration, as a means to foster computational thinking. These studies also underline the importance of designing learning experiences that are developmentally appropriate. However, most existing research tends to focus on activity-based or media-specific interventions, and relatively few have explored how computational thinking can be systematically integrated into a curriculum—particularly within the framework of Indonesia's Independent Curriculum.

This research offers innovation in two key areas. First, it focuses on learning strategies that are embedded directly into the structure of the national PAUD curriculum, rather than relying solely on specific activities or digital media. Second, it introduces the development of an implementation model based on the ADDIE framework, which was collaboratively designed and tested with teachers and school principals across 36 early childhood education institutions. This approach ensures that the strategies developed are contextually grounded, practically applicable, and replicable in real classroom settings. In doing so, this research addresses the gap between theoretical discourse on computational thinking and its practical application within curriculum design and early childhood education. It also provides a meaningful contribution to enhancing teachers' capacity to implement the Independent Curriculum effectively and purposefully.

## 2. Method

This research adopts a Research and Development (R&D) approach with the primary objective of producing a curriculum product for early childhood education units that integrates computational thinking skills. The ADDIE development model—comprising five stages: Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009)—was selected due to its systematic yet flexible nature, which aligns well with the dynamic needs of curriculum innovation in early childhood education. The study was conducted in 36 PAUD (early childhood education) units that are partner institutions of the Djarum Foundation, located in Kudus Regency, Central Java Province, Indonesia.

The main subjects involved in this study include the heads of PAUD units and teachers, who serve as curriculum developers; the researcher, who plays a dual role as both consultant and facilitator; and parents and children, who are directly involved during the implementation and evaluation phases. The research activities took place from October 2023 to May 2024, with each phase following the flow and structure of the ADDIE model. The details of these phases are outlined in Table 1, which maps the specific actions and focus areas within each stage of the model to ensure a structured and meaningful development process.

Tabel 1 Design of Research

| ADDIE Stages | Research Activities |
|---|---|
| Analysis | • Identify the needs of teachers and principals related to Understanding the national curriculum<br>• Analysis of teachers' understanding of computational thinking concepts and their implementation strategies<br>• Data collection through initial observations, surveys, and interviews |
| Design | • Preparation of learning objectives that integrate computational thinking in the curriculum of early childhood education units<br>• Formulation of curriculum structure and organization of contextual-based learning |
| Development | • Preparation of a draft curriculum for early childhood education units and learning planning documents<br>• Implementation of Focus Group Discussion (FGD) with all principals and teachers from 36 partner PAUD<br>• Product revision based on FGD input |
| Implementation | • Implementation of curriculum developed in all 36 PAUD units<br>• Teachers carry out learning according to a curriculum that has contained elements of computational thinking |
| Evaluation | The evaluation process is carried out qualitatively with the following techniques:<br>• Field observations by researchers<br>• In-depth interviews with teachers and parents<br>• Documentation of children's activities and teachers' reflections |

This study employs a fully qualitative approach, utilizing various data collection techniques to capture a comprehensive understanding of the research context. Participatory observation was conducted by the researcher during the learning implementation process, allowing for direct insight into classroom dynamics and the integration of computational thinking in real time. In-depth interviews were carried out with school principals, teachers, and parents to explore their perceptions and experiences related to a curriculum that incorporates computational thinking. Additionally, documentation was collected in the form of activity photographs, teachers' reflective notes, and samples of children's work, providing rich, contextual data.

The data analysis was conducted thematically through a process that included data reduction, categorization, and narrative interpretation. This approach enabled the evaluation of several key aspects: teachers' understanding and ability to implement computational thinking within the curriculum; observable changes in children's behavior, particularly in their capacity to think logically, independently, and in a structured manner; and parents' responses to the perceived impact of the program on their children's development. This thorough qualitative method ensures that findings are deeply rooted in the lived experiences of the participants and are contextually meaningful.

## 3. Result

### 3.1 Stage 1 – Analysis

The initial stage in the ADDIE development model is the **Analysis** phase, which aims to collect comprehensive information to identify existing needs, problems, and potentials before proceeding to curriculum design. In this research, all principals and teachers from the 36 partner PAUD units had previously participated in training sessions organized by the program, covering two main areas: computational thinking—introducing its concepts, principles, and applicable activity examples—and the inquiry approach, which emphasizes encouraging children to ask questions, explore, and draw conclusions independently. While these trainings provided a conceptual foundation, challenges emerged once teachers returned to their respective educational units and attempted to implement what they had learned within the framework of the Independent Curriculum.

Field observations revealed that although some computational thinking-based activities—such as sorting, patterning, and problem-solving—were conducted, they were generally treated as standalone tasks and not embedded into the formal learning plan. Furthermore, computational thinking components were often positioned as isolated learning objectives rather than being integrated into the broader curriculum outcomes. Alarmingly, in a few instances, children were asked to memorize components of computational thinking, reducing the concept to rote learning rather than experiential understanding. This disconnection stems largely from teachers' uncertainty and fear of incorrectly linking computational thinking with the goals of the Independent Curriculum, leading many to avoid deeper exploration altogether.

In-depth interviews further illuminated this confusion. Teachers and principals acknowledged acquiring theoretical knowledge during training but expressed difficulty translating it into concrete classroom practices aligned with the curriculum. Common questions included whether computational thinking is a learning goal, a teaching strategy, or a separate subject altogether. There was also confusion about the reappearance of the inquiry approach within a new framework, and uncertainty over how computational thinking fits within the broader, already complex structure of the Independent Curriculum. Many educators perceived computational thinking, inquiry, and the Merdeka Curriculum as three unrelated concepts, leading to feelings of overwhelm, fear of making mistakes, and the perception that computational thinking is an added burden rather than a supportive, enjoyable, and enriching element of early childhood learning.

From these findings, it is evident that a significant gap exists between training, educational policy, and classroom implementation. Addressing this gap requires: (1) a structured learning design that systematically connects the Independent Curriculum, inquiry-based learning, relevant learning strategies, and computational thinking components, and (2) the development of visual aids and practical frameworks that support teachers in creating and executing developmentally appropriate, integrated, and enjoyable learning experiences that incorporate computational thinking in a meaningful way.

### 3.2 Stage 2 – Design

Based on the analysis findings that revealed confusion among teachers and principals regarding the relationship between the Independent Curriculum, the inquiry approach, and computational thinking skills, the researcher—acting as a consultant—took strategic steps in the Design stage. The primary goal of this stage was to support educators in developing a comprehensive and integrative conceptual understanding, while also providing them with a practical and applicable learning framework.

The first step in this process was adopting a facilitative approach combined with conceptual visualization. This involved repositioning the roles and interrelationships of the three core components. The National Curriculum (specifically the Independent Curriculum) was framed as the overarching structure that provides the philosophical, juridical, and pedagogical foundation for all learning. The inquiry approach was reintroduced as a dynamic method of learning where children engage actively through exploration, observation, and meaning-making. Meanwhile, computational thinking was clarified as a set of 21st-century thinking skills—such as decomposition, abstraction, pattern recognition, and algorithmic thinking—that are not separate from, but rather integrated into, existing learning processes.

To make these relationships clearer, principals and teachers were invited to revisit and dissect the learning outcomes stipulated in the Independent Curriculum. Through guided reflection and collaborative discussions, they began to recognize the natural alignment between the competencies in the curriculum and the components of computational thinking. This process helped educators realize that computational thinking is not in conflict with the curriculum; on the contrary, it enhances the curriculum's emphasis on child-centered, inquiry-driven, and project-based learning. It also supports the development of independent, logical, and structured thinking in young children.

As a tangible outcome of these sessions, the researcher created a visual learning framework—developed collaboratively with teachers and principals—as a reference model for curriculum development and daily planning. The design structure includes several integrated elements:

1. The Independent Curriculum serves as the primary foundation guiding all learning directions.
2. Learning models such as group settings, learning corners, the BCCT approach, and the Reggio Emilia philosophy are offered as adaptable formats for organizing space and activities.
3. The inquiry approach is established as the central pedagogical strategy, promoting exploration and the construction of knowledge by the children themselves.
4. Differentiation strategies ensure learning is tailored to each child's individual needs and developmental level.
5. Project-based methods are positioned as the core instructional method, cultivating critical thinking, collaboration, and creativity.
6. A wide range of learning techniques, including discussion, question-and-answer sessions, experiments, simulations, and educational field trips, are encouraged for flexible implementation.
7. Finally, tactics refer to the specific teaching strategies and media choices used by educators to structure daily learning flows.

This integrative and visually accessible design supports teachers in transforming conceptual understanding into practical implementation, bridging the gap between curriculum policy and meaningful classroom practice.

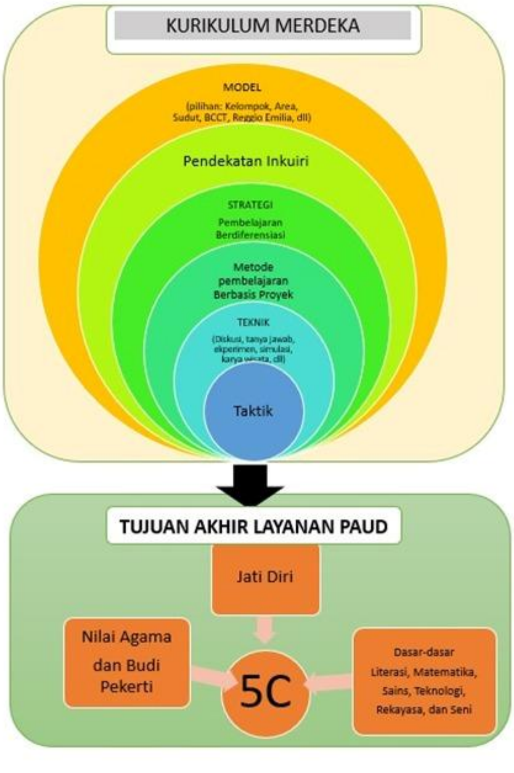


Figure 1 Learning Management Design in Early Childhood Education

Fostered by Djarum Foundation

The goal of all the layers within this integrated approach is to guide learning toward the ultimate objectives of Early Childhood Education (PAUD) services, which include: strengthening children's sense of identity, instilling religious values and ethics, and providing an introductory foundation to literacy, numeracy, science, technology, engineering, and the arts. These goals are designed to foster the development of 21st-century competencies (often referred to as the 5C skills): Critical thinking, Creativity, Collaboration, Communication, and Computational thinking. By addressing these competencies, the framework aims to equip children with essential skills that will support their growth in both academic and life contexts.

### Conclusion of the Design Stage

The Design stage has resulted in several key outcomes:

1. An integrated learning framework that effectively aligns the Independent Curriculum, inquiry approaches, and computational thinking skills.
2. A collaborative conceptual understanding that was co-constructed between teachers, principals, and researchers, ensuring that all stakeholders have a shared vision and understanding of the curriculum's goals and methodology.
3. A visual and narrative foundation that will serve as a basis for the preparation of the unit curriculum and detailed learning plans in the subsequent stages of the development process.

   This comprehensive design provides a clear roadmap for moving forward, ensuring that computational thinking and inquiry-based learning are not only conceptualized but practically embedded in early childhood education, supporting children's overall development and preparing them for the demands of the 21st century.

## 3.3 Stage 3– Development

After the learning design framework has been mutually agreed upon, the next step involves developing curriculum documents and learning plans that comprehensively integrate computational thinking skills into the Independent Curriculum. Before preparing a learning plan in line with the Merdeka Curriculum, it is essential for teachers to understand several key points. First, they need to recognize that computational thinking aligns with the learning objectives outlined in the curriculum. Teachers should also grasp the components of computational thinking so they can effectively prepare lesson plans, organize materials, structure the play environment, and support children during the learning process to achieve the set objectives while fostering computational skills.

The process of preparing the learning plan is carried out collaboratively between the researcher, acting as a consultant, and the teachers. The aim is to create a plan that is easy for teachers with varying levels of understanding to comprehend, flexible enough to be implemented in different early childhood learning models, and contextual, aligning with both children's play activities and the Independent Curriculum structure. The plan is designed in a simple yet structured manner to help teachers clearly understand the connection between learning objectives, play activities, teacher support, and the computational thinking skills to be nurtured. In the developed learning plan, computational thinking is not treated as a standalone goal, but is integrated into the learning objectives of the curriculum. Teachers are encouraged to guide children in thinking logically and systematically, through activities such as sequencing, pattern recognition, and classification, as well as in a critical and creative manner through exploration, problem-solving, and decision-making. It's important to note that children do not need to be taught technical terms like "abstraction" or "algorithms," but instead they naturally practice these concepts through play activities. This approach is necessary because earlier observations revealed that some teachers were asking children to memorize computational thinking components, rather than allowing them to engage with the concepts organically.

In developing the learning plan, teachers start by determining the learning objectives, which should align with the curriculum outcomes. Then, they design exploratory play activities that allow children to develop computational thinking skills through hands-on experiences. Teachers also create open-ended questions and reflective prompts to support children's thinking processes and prepare assessment tools that are aligned with the learning goals and computational thinking indicators. To ensure effective and consistent implementation, several key elements must be reinforced. Teachers need to be trained to understand how computational thinking connects with learning objectives, enabling them to confidently plan and implement the activities. Additionally, the play environment must be equipped with tools and materials that stimulate computational thinking, such as activities involving pattern recognition and grouping. Teachers also need to actively provide stimuli through questions and statements that guide children toward achieving the learning objectives and thinking in a structured manner.

Ultimately, teachers play a crucial role in this process, not only by delivering content but also by designing meaningful and challenging learning experiences. With a clear understanding of computational thinking, teachers are equipped to develop a structured and exploratory flow of activities, create a challenging learning environment, provide appropriate verbal and non-verbal support, and conduct assessments that reflect both the process and outcomes of children's exploration. This approach ensures that computational thinking is effectively integrated into early childhood education, fostering essential 21st-century skills in a developmentally appropriate and engaging manner.

## 3.4 Stage 4 – Implementation

At the implementation stage, the primary focus is ensuring that each participating PAUD (early childhood education) unit effectively understands and applies the curriculum, which serves as the foundation for preparing learning plans. The curriculum is used as a guide for implementing child-centered activities that foster computational thinking skills in children. Before full implementation, several key preparations were confirmed, such as: each PAUD unit having a well-understood curriculum by both teachers and principals, learning objectives being used as references for daily activity plans, and teachers receiving training on how to organize a play environment that not only supports developmental goals but also encourages computational thinking.

The integration of computational thinking into the learning process occurs through habituation and play activities. In habituation activities, teachers can stimulate computational thinking by incorporating simple routines. For instance, activities like washing hands or brushing teeth can be used to teach algorithms. Teachers might narrate a story and emphasize important details to simplify the content, which aligns with the concept of abstraction. Daily routines, like putting shoes in their designated place or storing a bag, are also examples of algorithms in action. In play activities, such as learning about shapes and sizes, children can be invited to build fences following specific patterns based on shape and size, which promotes pattern recognition. Additionally, during role-playing activities like cooking, children can practice writing down food recipes, reinforcing the concept of algorithms.

The implementation period lasted from January to May and was executed across all 36 partner PAUD units. Observations during this phase yielded several positive findings. The learning process became increasingly child-centered, with children actively participating in activities based on their interests and developmental needs. The learning plans followed the unit curriculum, demonstrating clear objectives and a systematic arrangement. Computational thinking skills began to emerge naturally through activities facilitated by teachers, such as grouping, recognizing patterns, sequencing steps, solving problems, and making decisions. The environment was designed to be rich in stimuli that encouraged thinking, and teachers provided significant support through open-ended questions and reflective statements. Children displayed increased enthusiasm, engaging with activities joyfully and showing improvements in their ability to think in a structured and systematic way.

Feedback from both parents and teachers was overwhelmingly positive. Parents reported that their children were more enthusiastic about attending school and exhibited more logical, coherent, and reflective thinking at home. Teachers expressed a greater understanding of how to structure and implement learning that fosters computational thinking. One teacher remarked, "I used to be confused about how to teach computational thinking. Now I understand that this is not a subject, but part of the child's process of thinking and learning." This stage of implementation highlights that with a clear curriculum, systematic planning, a supportive learning environment, and teachers who understand their roles, computational thinking skills can naturally develop and integrate into early childhood education.

## 3.5 Stage 5 – Evaluation

The final stage of the ADDIE model, Evaluation, aims to assess the effectiveness of the curriculum implementation and identify areas for improvement. While the overall implementation of the curriculum integrating computational thinking showed positive results, the evaluation process, which involved follow-up observations, reflective discussions, and teacher interviews, uncovered several challenges that need to be addressed. One of the issues highlighted was that in some PAUD units, particularly those with limited space or facilities, learning activities were still dominated by teacher-centered approaches. Teachers mentioned that the small spaces restricted children's ability to move and explore freely, which led to more instructional activities rather than child-driven exploration. Additionally, there was a gap in teacher reinforcement during the learning process. Despite understanding the importance of providing verbal and non-verbal support to encourage computational thinking, some teachers were inconsistent in using open-ended questions, reflective affirmations, or offering strategic guidance to foster critical thinking and problem-solving skills.

Another challenge that emerged was the pressure from parents for their children to acquire basic literacy and numeracy skills (calistung) at an early age. Some teachers reported that this pressure led to a focus on calistung drills, which conflicted with the play-based learning approach designed to foster higher-level thinking skills. This situation created tension between meeting parental expectations and adhering to the curriculum's emphasis on meaningful, process-oriented learning. In response to these challenges, the evaluation recommended several follow-up actions. First, special advanced training should be provided to PAUD units struggling with implementing child-centered learning. Additionally, there is a need to strengthen communication with parents to help them understand the value of meaningful thinking and learning processes at an early age, rather than prioritizing early academic achievements. The management of PAUD units should also be encouraged to optimize available space and support teachers in arranging a conducive learning environment that facilitates exploratory play and the development of computational thinking. Although these challenges were found in a small number of PAUD units, they are significant enough to warrant further attention. With appropriate follow-up strategies, it is hoped that the process of developing computational thinking in early childhood education will continue to be sustainable and equitable across all educational units. The evaluation demonstrates that, with the right support, the majority of PAUD units have successfully implemented the curriculum, and these adjustments will help ensure its continued success and development.

## 4. Discussion

The evaluation of the implementation of a curriculum integrating computational thinking skills in early childhood education (PAUD) reveals findings that align with existing educational theories. Constructivist theory, as proposed by Jean Piaget and Lev Vygotsky, asserts that children learn through active experiences in building their own knowledge. In this context, the application of computational thinking skills, such as decomposition and pattern recognition, aligns with the principles of constructivism, which emphasizes the importance of exploration and direct experience. However, the evaluation results indicate that in some PAUD units, learning activities are still too teacher-centered, not providing enough space for children to actively construct their knowledge. This contradicts the core principles of constructivism, which emphasize the child's role in building their own understanding. Vygotsky's theory of the Zone of Proximal Development also highlights the importance of social support provided by teachers to help children advance further, which unfortunately has not been fully implemented in some cases in the field.

Additionally, the theory of play-based learning, developed by Whitebread (2012), emphasizes that play is an effective way for children to develop cognitive and social skills. This study shows that the integration of computational thinking skills through play activities, such as recognizing patterns in house building or using algorithms in role-play, can stimulate children's critical and creative thinking. However, challenges arise when there is pressure from parents for children to quickly acquire early literacy and numeracy skills (known as calistung), which leads to more structured learning activities that provide less room for creative exploration. This aligns with findings in the research by Lee et al. (2016), which indicates that while play-based learning can support children's cognitive development, academic pressures often lead to teacher-centered approaches that are less flexible.

Further research on the integration of computational thinking skills in early childhood education, such as the work by Bers (2018), emphasizes that these skills can be introduced early through play experiences that involve pattern recognition, algorithms, and problem-solving. This research suggests that computational thinking skills do not need to be taught as a separate subject but can be integrated into everyday learning activities based on exploration and experimentation. However, the challenges found in this evaluation indicate confusion among teachers about how to integrate computational thinking skills into existing curricula. This highlights the need for additional training for teachers to understand and apply computational thinking in the context of early childhood development, as emphasized by Grover & Pea (2013).

The evaluation also points to the important role of parents in supporting this learning process. Pomerantz & Eaton (2001) highlight that effective communication between teachers and parents is crucial in supporting children's development. In this context, the finding about pressure from parents for a focus on calistung shows a misalignment between parental expectations and the curriculum's focus on developing computational thinking skills. Therefore, enhancing communication with parents is essential to help them understand that developing critical and creative thinking skills is an integral part of early childhood education, rather than just academic achievement.

Overall, while most PAUD units have successfully implemented the curriculum, challenges remain, such as inconsistent teacher support, limited space and facilities, and pressure from parents to focus on academic skills. To address these challenges, follow-up strategies are needed, such as additional training for teachers, improving parent understanding, and optimizing the play environment in PAUD units. With these steps, the development of computational thinking skills is expected to continue in a sustainable and equitable manner across all PAUD units

## 5. Conclusion

This research aims to develop strategic steps for integrating computational thinking skills into the implementation of the Independent Curriculum in Early Childhood Education (PAUD) using the ADDIE development model. The research was conducted in 36 PAUD units partnered with the Djarum Foundation in Kudus Regency, Central Java. The research process followed the five stages of the ADDIE model: Analysis, Design, Development, Implementation, and Evaluation.

The Analysis stage involved identifying the needs of teachers and principals regarding the understanding of the national curriculum, computational thinking (CT), and inquiry approaches. The findings revealed that while teachers had participated in training sessions, they still struggled to connect these concepts to their learning activities in alignment with the Independent Curriculum.

In the Design stage, the researcher, acting as a consultant, facilitated the creation of a visual framework to clarify the relationship between the curriculum, inquiry, and computational thinking. Teachers were encouraged to view CT not as a separate goal but as an integral part of the thinking process in early childhood learning. This helped provide a clear structure for integrating CT into daily teaching practices.

During the Development stage, computational thinking was embedded within the learning objectives of the Independent Curriculum rather than being treated as a standalone goal. Collaborative planning with teachers led to the creation of teaching modules and learning plans that integrated CT into activities such as exploratory play, teacher support through open-ended questions, reflective guidance, and relevant assessment instruments. These components were designed to align with the learning outcomes and help develop computational thinking skills through hands-on experiences.

The Implementation phase, which took place from January to May, involved teachers applying the child-centered, curriculum-based learning plan. This phase allowed the integration of computational thinking through a well-organized play environment and teacher interactions. Habituation activities, such as following routines, and play activities, like recognizing patterns or creating algorithms, were used to stimulate the development of computational thinking in children.

In the Evaluation stage, most of the PAUD units successfully implemented the strategy. However, challenges such as teacher-centered learning, insufficient teacher verbal support, and parental pressure for early literacy and numeracy achievements (calistung) were identified. Despite these challenges, the evaluation emphasized that the integrative strategy model developed during this research was effective in promoting the development of computational thinking skills in early childhood education in a contextually appropriate manner and aligned with the Independent Curriculum.

While the research did not produce a new physical curriculum product, it provided an implementive strategy model that outlined practical steps for integrating computational thinking into early childhood learning. This model serves as a foundation for future development in PAUD curriculum implementation.

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