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Deep learning approach: Teachers' strategies in stimulating critical thinking skills in AUDs

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ABSTRAK:
The development of critical thinking skills in early childhood is an important foundation in facing the challenges of the 21st century, but learning practices are still dominated by memorization (surface learning) which is less effective. This descriptive qualitative research aims to analyze teachers' strategies in applying the Deep Learning approach to stimulate critical thinking in early childhood through in-depth interviews with eight early childhood teachers and a review of related literature. The results revealed three effective strategies: (1) designing exploration-based activities and collaborative projects,
(2) utilizing concrete media and interactive technology, and (3) providing process- oriented feedback. The main challenges include teachers' limited understanding of critical thinking indicators, a crowded curriculum, and minimal parental involvement. The study concluded that the Deep Learning approach has optimal potential if supported by: competency-based teacher training, curriculum simplification, and technology integration. Research recommendations include developing teacher training modules and evaluation models that focus on children's thinking processes.

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1. Introduction

The Golden Age period in early childhood is an important period for developing critical thinking skills because children's brains are growing rapidly and easily absorb information. Proper stimulation from parents and teachers in this phase can form the basis of critical thinking skills that are useful for life (Imamah & Muqowim, 2020). Critical thinking itself is the ability to analyze problems logically, evaluate information appropriately, and make decisions based on evidence, thus helping a person face challenges more effectively (Hidayat et al., 2020).

In the 21st century, which is full of rapid change and complexity, developing critical thinking skills in early childhood is very important because it equips them with the analytical, evaluative, and problem-solving abilities needed to face future challenges. These skills not only help children organize new ideas and understand various perspectives, but also allow them to make logic and evidence-based decision (Cahyaningsih & Harun, 2023). The development of critical thinking skills starts from active learning motivation, connecting experience with knowledge, to achieving complex thinking according to Piaget's developmental stages, thus forming a strong foundation for children's intellectual and social development (Susan, 2023).

Early childhood can develop critical thinking skills through materials and methods that are appropriate to their concrete thinking stage, given that children's knowledge structure is significantly different from adults. Children who think critically are usually highly curious and actively explore the world around them (Anggreani, 2015). They tend to ask "how" and "why" questions, collect evidence, dare to express opinions, and generate new ideas in decision-making. These skills help them get used to solving problems critically, although the development of each child is different depending on experience and environmental stimulation (Reswari, 2021). The surrounding environment plays a crucial role in shaping children's critical thinking skills, where rich interactions with learning challenges can strengthen the

foundation of critical thinking, preparing them to face complex situations in the future with more confidence (Hartini, 2017).

The development of critical thinking skills in early childhood is strongly influenced by various surrounding environments. In the family environment, cognitive stimulation through books and educational games can foster curiosity and form the basis of critical thinking. While at school, the role of the teacher is vital in creating learning activities that stimulate analytical thinking through discussion and appropriate learning challenges (Naisa, 2023). More than just a teacher, teachers act as facilitators who guide children's thinking process by creating an interactive and supportive learning environment (Fitriyah & Ramadani, 2021). Equally important, the community environment contributes by providing learning resources such as libraries, complementing the cognitive stimulation children receive from family and school.

Various studies show the importance of developing a more comprehensive understanding of critical thinking in early childhood. A study by (Robson & Hargreaves, 2007) revealed that practitioners' understanding tends to limit critical thinking only to the problem-solving aspect, without considering its role in children's conceptual development, imagination, and creativity. This narrow view has the potential to hinder the holistic development of children and adults. This finding is reinforced by (Haryono, 2023) which shows the limitations of critical thinking skills in children, such as difficulties in understanding explanations without repetition, limitations in drawing detailed conclusions, and the lack of critical questions related to learning materials and feedback on friends' actions. These conditions indicate the need for a broader approach in developing children's critical thinking, covering various cognitive aspects and learning contexts, so that they can apply their thinking skills more optimally in various situations.

ECD teachers face multidimensional challenges in developing early childhood critical thinking skills, which include conceptual limitations, teaching readiness, and practical constraints in the field. Conceptually, many educators have difficulty understanding and implementing critical thinking because there is no standardized operational definition, plus the lack of specific training on stimulation techniques such as reflective dialogue or storytelling methods (O'Reilly et al., 2022). In implementing the Merdeka Curriculum, challenges are increasingly complex because teachers are required to act as facilitators who must design exploratory learning that requires high creativity amid limited infrastructure (Sope & Murtono, 2024). Another challenge arises from the characteristics of children's own development; language and cognition limitations make children's critical thinking skills often implicit and difficult to measure, while most teachers have not been trained in qualitative assessment techniques to evaluate children's thinking processes (Kwambaza, 2024).

Deep learning offers a comprehensive solution to teachers' challenges in stimulating AUD critical thinking through the integration of three approaches: (1) mindful learning with reflective question-based scaffolding techniques to develop children's metacognition, (2) meaningful learning through contextual activities such as simple experiments using everyday objects, and (3) joyful learning with structured games to hone analytical skills in a fun setting. This integrated implementation overcomes the limitations of conventional methods by: (a) reducing reliance on memorization through meaningful learning, (b) mitigating resource constraints by utilizing environmental materials, and (c) providing an alternative assessment framework through observation of children's thought processes during activities (Diponegoro et al., 2021; Putri et al., 2022).

Deep learning in education is based on the constructivism principles of Piaget (1971) and Vygotsky (1978), which synergistically emphasize the active role of learners in constructing knowledge. Piaget highlighted the importance of direct experience to form cognitive schema, while Vygotsky through his ZPD concept underlined the role of social scaffolding in learning. In Indonesia, this philosophy is manifested in the Merdeka Curriculum through project-based learning and differentiated learning that aligns with the three pillars of deep learning: (1) active student engagement in exploration and collaboration (overcoming passive learning), (2) development of metacognition through critical reflection (Biggs & C Tang, 2011), and (3) customization to students' individual needs - an approach that simultaneously addresses the demands of constructivism theory and national education policy.

While extensive research has examined the deep learning approach in primary and secondary education, its implementation in early childhood education (ECE) particularly for cultivating critical thinking skills remains underexplored. Existing literature predominantly focuses on theoretical frameworks of meaningful, joyful, and mindful

learning (Pyle & Danniels, 2017), with limited empirical investigation into teachers' practical pedagogical strategies for fostering critical thinking. This gap is especially pronounced given the unique developmental needs of young children, whose emerging verbal and cognitive capacities necessitate highly contextualized teaching methods (Dlab et al., 2019). Current studies have yet to systematically document how educators adapt deep learning principles to overcome these developmental constraints. Thus, there is a pressing need for empirical research to analyze classroom-based applications of deep learning by ECE teachers to nurture critical thinking competencies.

Based on the limited empirical studies on the implementation of deep learning in early childhood education, this study aims to explore teachers' practical strategies in implementing the approach. Special focus is given to two critical challenges: (1) adaptation of deep learning principles (mindful, meaningful, joyful learning) according to the stage of cognitive development of concrete operational early childhood and (2) pedagogical innovation in the context of limited resources. Thus, this research question is formulated as follows: How do early childhood teachers design and implement deep learning-based strategies to stimulate critical thinking in young children, taking into account the unique characteristics of child development and resource constraints in real learning settings?

2. Methodology

This research uses a descriptive qualitative approach with a multi-participant case study of 8 PAUD teachers who were purposively selected based on the criteria: (1) at least 3 years of experience, (2) have implemented deep learning elements, and (3) work in schools with limited infrastructure. Data were collected through triangulation of semi-structured interviews focusing on deep learning adaptation strategies, participatory observation to document scaffolding practices, and document review of learning tools. Data analysis followed the Huberman & Saldana (2014) model through data reduction with deep learning theory-based coding, presentation of teacher strategy matrix, and verification via member check and triangulation of methods. This approach was specifically designed to answer the research question about the implementation of deep learning in AUD. The following data analysis was used:

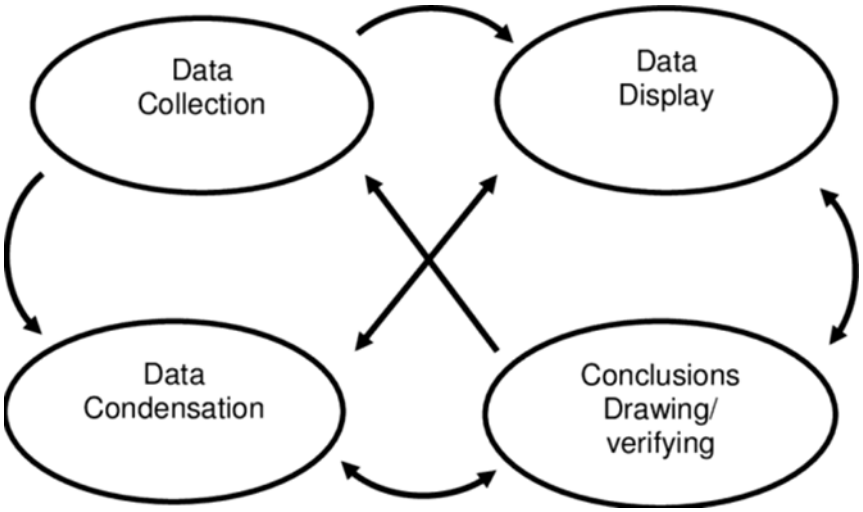


Figure 1 . Huberman&Saldana 2014

3. Result and Discussion

To foster critical thinking skills in early childhood, teachers need to provide learning strategies and materials that are innovative, interactive, and in line with children's world. The learning environment must be created in a meaningful and fun way so that children are actively involved. The deep learning approach is key in this process, as it encourages children to think deeply, reflectively and connect with real experiences. Through training and implementing deep learning, teachers can improve children's skills in literacy, numeracy and independent and critical decision-making (Hadi et al., 2021; Zulfikar & Yuliantina, 2025).

The study employed a descriptive qualitative approach to explore teachers' strategies in fostering critical thinking skills in early childhood through deep learning. Data were collected from in-depth interviews with eight early childhood teachers and a review of relevant literature. The findings revealed several key strategies and challenges in implementing deep learning to stimulate critical thinking in young children.The following is a question instrument compiled by researchers in describing the role of teachers in the planning, implementation, and evaluation stages to develop critical thinking skills in early childhood through deep learning:

A. Part A - Learning Planning

1. How do you develop learning objectives that foster children's critical thinking skills? Does it involve problem solving, analysis or exploration?
2. What initial activities do you design to spark children's curiosity before learning begins?
3. Do you relate the lesson plan to the context of children's real life? What is an example of this?

Based on relevant research and interview results that designing learning objectives to foster critical thinking in early childhood should include three main aspects: problem solving (such as cause-and-effect experiments), analysis (e.g. classifying natural objects), and open-ended exploration (through simple STEAM projects) (Motimona & Maryatun, 2023; Mulyadi et al., 2021). To trigger curiosity from the beginning of learning, teachers can use demonstrations of surprising phenomena (e.g. water "disappearing" in the sand), provocative questions ("What happens if ice is left outside?"), or problem-stories that stimulate children's curiosity (Susan, 2023; Zulkarnaen et al., 2023). It is also important to relate the material to real-life contexts, such as comparing the texture of food ingredients in the school kitchen or exploring the causes of flooding after heavy rain in the neighborhood, so that children can connect learning to their daily experiences (Fitriyah & Ramadani, 2021; Hartini, 2017). The implementation of this approach requires flexible curriculum support (Nadhiroh & Anshori, 2023) and collaboration with parents to enrich the learning context at home (Reswari, 2021).

B. Part B - Learning Strategies and Methods

4. Have you used a project approach or children's independent exploration? Tell us an example.
5. Have you used the STEAM approach in your classroom? In what form of activities?
6. How do you provide real challenges or problems in children's learning activities?

In learning practice, project-based approaches and independent exploration have proven effective in developing children's critical thinking. One example implemented by the teacher is the "Making a Mini Garden" project, where children research the needs of plants (water, light, soil) through direct observation for two weeks. This activity not only trains problem solving, but also encourages children to ask, "Why does plant A grow more vigorously than plant B?". An interview with a teacher revealed, "Children become more interested when they are actively involved in long-term projects like this, because they can see real changes from what they do" (ECD Teacher Interview, 2025).

The STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach is also widely applied in the form of integrated activities. For example, color mixing experiments using natural materials (turmeric for yellow, pandan leaves for green) combined with painting. This activity trains children to understand science concepts (color changes), as well as hone their creativity (Fadillah & Yusuf, 2022). One research participant added, "I use blocks to introduce simple math concepts, such as grouping by shape and size, while encouraging children to design buildings" (ECD Teacher Interview, 2025). This finding is in line with research (Mulyadi et al., 2021) which showed that a concrete-based STEAM approach improved children's analytical skills by 30%. To provide real challenges, teachers often present contextual problems such as: "How can we save a toy that has fallen into a container without putting our hands in?" or "What happens if we don't water the plants for a week?" (Mu'ti et al., 2025). These problems are designed to trigger critical thinking by testing simple hypotheses, while developing the problem-solving skills that are at the heart of Deep Learning. Approaches such as problem-based storytelling - for example when children are invited to help a story character who is lost in the forest - not only exercise creativity and independence, but also integrate the principles of mindful, meaningful and joyful learning. Such activities create a collaborative learning environment where questioning and exploration are valued over correct answers, while implementing innovative pedagogical practices that combine conventional methods with the use of technology. Through contextual challenges like this, learning not only achieves dimensions of the graduate profile such as critical reasoning and creativity, but also embodies

the essence of the Merdeka Curriculum which emphasizes holistic learning experiences through the stages of understanding, applying, and reflecting.

C. Part C - Media and Technology

7. What kind of media or technology do you use to support deep learning?
8. Does the use of this media increase children's participation and critical thinking? What are your observations?
9. To what extent are children involved in the process of finding solutions using props or concrete learning resources?

To support deep learning, various media and technologies that are close to the child's world are strategically used. Collaborative platforms such as Zoom or Google Meet are used for interactive distance learning. Apps that are already familiar to children are utilized to deliver material through games, quizzes, or simulations, so that the learning concept feels more fun and easy to understand, especially the use of interactive power points.

The use of these media has been proven to increase active participation and hone children's critical thinking skills. Online discussions, educational games and digital projects provide space for children to express opinions, ask questions and work together to solve problems. Authentic assessments such as e-portfolios and daily reflections allow them to self-assess their learning progress, encouraging self-awareness and responsibility in the learning process (Diputera, 2024; Zulfikar & Yuliantina, 2025).

Children's involvement in finding concrete solutions is also an important part of this approach. In contextualized projects such as making water filters from recycled materials or growing vegetables in the school garden, children are involved from the planning stage to the presentation. Props such as three-dimensional models, natural materials or everyday objects are used to bridge abstract concepts into reality (Anita Yus et al., 2024). Children act as active problem solvers with the freedom to choose methods, tools and strategies that suit their interests and abilities. This approach fosters student agency, which is the ability to take roles and initiatives in their own learning process.

D. Part D - Child Activities

10. How do you give children space to express their opinions or ideas during learning?
11. Tell us how you guide the child to make observations and draw simple conclusions.
12. What is your strategy for encouraging children to ask or answer open-ended questions?

In implementing the deep learning approach, teachers provide space for children to express their opinions and ideas through various interactive methods. Open discussion is one of the main strategies, where teachers ask sparking questions such as "How can we reduce waste at school?" to stimulate the active participation of each child. To guide children in making observations and drawing simple conclusions, teachers apply a real context-based inquiry approach. Children are invited to observe direct phenomena such as plant growth using concrete props, then guided through a series of scaffolding questions designed in stages: from observation questions ("What do you see?"), analysis ("Why does this happen?"), to application ("How can we change it?"). Collaborative activities such as drawing conclusions using graphic organizers help children develop analytical skills while learning to work together in teams.

Strategies to encourage children to ask and answer open-ended questions are developed through various stimulation techniques. Teachers use provocative questions such as “What would happen if...?” to trigger children's natural curiosity. Role-playing methods, where children play the role of scientists or detectives in solving simple problems, create a learning atmosphere that is both fun and challenging (ECD Teacher Interview, 2025).

Consistent implementation of these strategies not only encourages the development of early childhood critical thinking skills, but also creates a participatory and meaningful learning environment. The deep learning approach that integrates conventional methods with digital innovations is proven to be effective in forming independent learners who are able to actively construct knowledge, apply it in a real context, and critically reflect on their learning process. The findings provide a strong theoretical and practical basis for the development of learning in early childhood education (Dewi et al., 2025; Mailani et al., 2025).

E. Part E - Evaluation and Reflection

13. How do you evaluate children's critical thinking skills in daily life?
14. Do you provide opportunities for children to reflect on their learning? What is the method?
15. How do you adapt critical thinking strategies to different children's development?

I evaluate children's critical thinking skills through direct observation of how they deal with everyday situations. For example, when resolving play conflicts or planning group activities, I pay attention to how children identify problems, propose solutions and evaluate their choices. Based on deep learning, this approach aligns with the 'applying' stage of deep learning where knowledge is applied in a real context. I use anecdotal notes and simple checklists to assess indicators such as questioning ability, flexibility of thinking, and perseverance in solving problems (ECD Teacher Interview, 2025).

Reflection is an integral part of the learning process in our classroom. Each activity ends with a sharing session where children are invited to share their experiences through various methods. For the more verbal children, we conduct open discussions with sparking questions such as "What challenges did you face?" or "How did you feel during the activity?". For the more visual children, we use pictures or emojis to express their thoughts. As described in deep learning, this practice supports the development of self-regulation and metacognitive awareness. We also create a learning portfolio that allows children to see their progress over time (ECD Teacher Interview, 2025).

In applying critical thinking strategies, I always consider the developmental diversity of the children in the class. For children who need more support, I use scaffolding with guiding questions and concrete examples. For more advanced children, I challenge them with open-ended problems that require deeper exploration. We design project-based learning with various levels of difficulty so that each child can participate according to their abilities in accordance with the nature of learning with projects (Cholilah et al., 2023). I also form heterogeneous groups where children can learn from each other, while developing social and collaboration skills.

F. Section F - Collaboration and Learning Environment

16. Do you involve parents in the process of developing children's critical thinking? What form does this take?
17. How do you organize the classroom environment to support active and explorative learning?
18. Give an example of a real experience-based activity you have used in learning.

We actively engage parents through several approaches. First, we hold monthly workshops to introduce simple critical thinking stimulation strategies that can be implemented at home, such as open-ended questioning techniques and problem-solving games. Secondly, parents are involved in collaborative projects, for example when children make observations of the surrounding environment, parents are asked to document the child's learning process through photos or short notes. Thirdly, we use digital platforms to share daily classroom activities so that parents can continue the discussion at home. This form of engagement is in line with the principle of "meaningful learning" which emphasizes the importance of connecting school experiences with children's real-life contexts (ECD Teacher Interview, 2025).

Our classroom environments are designed to encourage independent exploration and collaboration. This arrangement supports the principle of a "joyful learning environment" by ensuring easy access to a variety of learning resources. We also utilize the classroom walls to display thought-provoking questions and the results of children's thinking. One of our successful activities is the "Recognizing Weather Patterns" project which is adapted from a deep learning approach. The children were invited to: (1) Observe and record daily weather changes for a week using simple symbols, (2) Experiment to make miniature houses from various materials and test their resistance to "rain", (3) Discuss how to protect themselves from extreme weather, and (4) Make a simple campaign poster about preparing for the rainy season. These activities cover all stages of deep learning (understanding-applying-reflecting) while developing observation, analysis and problem-solving skills in a context relevant to children's lives.

G. Section G - Support and Challenges

19. Have you participated in any training related to deep learning or early childhood critical thinking approaches?
20. What are the challenges you face in implementing deep learning approaches in the ECD classroom?

Training on deep learning or critical thinking approaches for early childhood has been introduced in various ECD teacher development forums. A study (Lukmanulhakim et al., 2025) shows that deep learning-based training is very helpful for ECD teachers in understanding the importance of creating learning that fosters curiosity and reflective thinking in children. Such training usually includes the integration of play activities, exploration of the surrounding environment, and the development of simple projects relevant to the child's world.

The implementation of deep learning approaches in early childhood classrooms is not free from challenges. For example, teachers' limited understanding of the concept of deep learning is still a major obstacle, especially in areas where access to training and literature is limited. Most ECD teachers are not accustomed to designing activities that encourage children's higher-level thinking, as the approach used is still predominantly teacher- centered and instructional in nature. Other challenges include limited physical resources such as teaching aids and classrooms that support explorative activities, as well as lack of support from parents who do not fully understand deep learning approaches. In addition, the diversity of children's characters in ECD classrooms requires teachers to be able to facilitate an individualized approach, which is often difficult to do in one learning time.

The concept of deep learning in the context of developing critical thinking in early childhood can be understood as a holistic approach that emphasizes the process of active, contextual, and reflective construction of knowledge. Three main principles are interrelated: awareness, meaningful, and joyful. In practice, this approach is translated through a series of learning experiences designed to stimulate children to question, analyze and critically evaluate information, while applying it in real situations.

The concept of deep learning is a systemic and transformative approach that aims to create meaningful, relevant and impactful learning experiences for learners. It does not only emphasize changes to classroom teaching methods, but also encompasses the entire ecosystem of the education unit. This includes visioning, transformative leadership, collaborative culture, student-centered pedagogical strategies, and evaluation systems that encourage reflection and continuous growth (Rahman & Cahyawati, 2025).

According to (Fullan et al., 2018) there are five key components that influence the success of deep learning implementation. First, the school vision and goals must explicitly reflect a commitment to deep learning and be understood by all school members. Second, leadership plays an important role as a driver of innovation who is able to inspire, empower and model change. Third, a collaborative culture needs to be built between teachers, students, parents and the community to create mutually supportive learning. Fourth, the depth of learning is realized through project- based approaches, inquiry, and the development of 21st century skills. Fifth, the new evaluation and measurement is authentic, formative and holistic, focusing on the process and student understanding, not just the end result.

The integration of technology and concrete learning resources (such as nature experiments or community-based projects) enriches this experience. This approach aligns with modern research findings (e.g., Fullan & Langworthy, 2014) that emphasize that deep learning is effective when children are emotionally and cognitively engaged in meaningful tasks. Thus, deep learning for critical thinking is not just a method, but a learning ecosystem that integrates innovative pedagogical approaches, authentic assessment and collaboration with parents or communities as illustrated throughout the research. The key to its success lies in the teacher's ability to act as a facilitator guiding the child through the cycle of understanding-applying-reflecting, while maintaining an element of fun and contextual relevance.

4. Conclusion

This research proves that the Deep Learning approach is effective in developing early childhood critical thinking skills through three main strategies. First, through exploration activities and collaborative projects. Second, the use of concrete media and interactive technology successfully increases children's active participation and deep understanding. Third, providing process-oriented feedback through authentic assessments such as observation and portfolios can facilitate children's independent reflection. However, the implementation of this approach faces several challenges, including teachers' limited understanding of early childhood critical thinking indicators, a dense curriculum that makes it difficult to take an exploratory approach, and suboptimal parental involvement.

Based on these findings, this study concludes that the Deep Learning approach will be more optimal if supported by competency-based teacher training for mastery of critical thinking stimulation strategies, simplification of a more flexible curriculum, and targeted technology integration. This finding strengthens the empirical evidence that the application of Deep Learning with the principles of mindful, meaningful and joyful learning can form the foundation of critical thinking in early childhood that is relevant to the challenges of the 21st century.

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