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IMPLEMENTATION OF DEEP LEARNING MODELS TO THE COGNITIVE DEVELOPMENT OF EARLY CHILDHOOD

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Abstract

Cognitive development is an important aspect influenced by the application of learning models in early childhood. The aim of this research is to determine the effect of the application of the deep learning model on the cognitive development of children aged 4–5 years at PAUD Weldy Kuanheum. The method used in this research is quantitative with an ex-post facto research design. The sampling technique used total sampling, comprising all 10 children aged 4–5 years at PAUD Weldy Kuanheum. Data were collected using questionnaires with instruments in the form of a deep learning model scale and a cognitive development scale. The data analysis technique used was simple linear regression with the SPSS 25.0 program. The results found that the deep learning model had a positive and significant effect on the cognitive development of children aged 4–5 years, with an R Square value of 0.213, or 21.3%, while the remaining 78.7% was influenced by other factors. The value of p = 0.001 ($p < 0.05$) indicates that the hypothesis is accepted. This shows that the consistent and structured application of the deep learning model can have a meaningful impact on the cognitive development of early childhood. It is expected that teachers can implement a deep learning model based on the principles of Mindful, Meaningful, and Joyful learning, in order to create child-centered learning, so that children feel active, comfortable, enthusiastic, and motivated in developing their cognitive abilities and critical thinking skills from an early age.

Keywords: *: Deep Learning Models, Cognitive Development, Learning Outcomes,*

INTRODUCTION

Early childhood education (ECE) serves as an important foundation in building children's basic abilities from birth to six years of age, a period known as the *golden age*. During this period, the child's brain develops rapidly, reaching approximately 80% of adult brain capacity, making appropriate and quality stimulation essential to holistically and integratively optimize children's potential across physical-motor, cognitive, social-emotional, language, and religious-moral dimensions (Faizah et al., 2023; Salahudin et al., 2022). Ministerial Regulation No. 58 of 2009 on National Standards for Early Childhood Education affirms that growth and developmental stimulation must be provided comprehensively and in an integrated manner from an early age as a foundation for educational success at subsequent levels (Suprayitno & Nuraeni, 2021).

One of the most crucial developmental aspects to cultivate in early childhood is cognitive development. Cognitive development encompasses the child's ability to think, solve problems, understand concepts, and develop memory and creativity (Nurjannah & Amseke, 2023; Salahudin et al., 2022). Ministerial Regulation No. 58 of 2009 on Early Childhood Education Standards specifies that cognitive developmental milestones for children aged 4–5 years include the ability to recognize objects by function, use objects in symbolic play, recognize simple concepts in daily life, and understand activity patterns and the importance of time. Vygotsky (in Kurniawan et al., 2022) adds that children's cognitive development is greatly influenced by social interaction and *scaffolding* provided by surrounding adults, including teachers as learning facilitators

Problems in cognitive development that occur in early childhood include low critical thinking ability, insufficient exploration drive, and limited capacity for independent problem-solving. Research by Amseke et al. (2024) found that most early childhood children show suboptimal cognitive ability, particularly in problem-solving and symbolic thinking. This is inseparable from the learning models applied by educators in the teaching and learning process. Conventio nal learning approaches tend to provide insufficient space for children to think deeply and meaningfully (Hidayat et al., 2023). A similar condition was found by Tanzeh et al. (2023), showing that teacher-centered learning models result in low active participation of children in the learning process and limited development of higher-order thinking skills.

Khadijah and Gusman (2021) found that nearly 60% of children aged 4–5 years in several ECE schools in Medan City had not yet reached cognitive developmental indicators appropriate to their age, particularly in number concept recognition and simple problem-solving. These children tended to exhibit thinking skills that were still concrete and entirely dependent on teacher assistance, with very limited independent thinking and exploration. This was compounded by minimal use of contextual learning media and insufficient variation in teaching methods. Meanwhile, Wahyuni and Fadhilah (2022) revealed that low cognitive ability in early childhood is also closely associated with a lack of active and exploratory stimulation from the learning environment, both at school and at home.

Their study involving 75 children aged 3–5 years in South Kalimantan showed that children who received only passive learning had significantly lower cognitive ability scores than those who received active and exploration-based learning ($p < 0.05$). Furthermore, Pratiwi et al. (2023) asserted that one root cause of cognitive developmental problems in early childhood lies in the mismatch between the applied learning approach and children's developmental needs. Their study of 120 children at ECE schools in Central Java found that teacher-centered approaches with limited space for children's active participation resulted in lower critical thinking, creativity, and problem-solving abilities. The findings of all three studies consistently indicate that cognitive problems in early childhood do not originate solely from internal child factors, but are also greatly influenced by the quality of the approach and learning model applied by educators (Khadijah & Gusman, 2021; Wahyuni & Fadhilah, 2022; Pratiwi et al., 2023).

In early childhood, cognitive development is an extremely important aspect that cannot be overlooked in the educational process, because the abilities to think, understand, and solve problems developed from an early age will become the foundation for children's academic success at subsequent educational levels. Piaget (in Suprayitno & Nuraeni, 2021) explains that children aged 4–5 years are in the preoperational stage, during which the brain is in a highly dynamic and plastic developmental phase, making appropriate cognitive stimulation during this period highly significant for overall child development.

Vygotsky (in Kurniawan et al., 2022) wrote that children's highest cognitive development is reached through appropriate *scaffolding* provided by more competent teachers or adults. Khadijah and Gusman (2021) affirm that optimal cognitive development in early childhood includes children's ability to recognize concepts, think symbolically, solve simple problems, and develop creativity — all of which must be stimulated through rich, varied, and contextual learning experiences. Rahayu et al. (2024) add that cognitive development in early childhood cannot be separated from the quality of the learning approach applied, where meaningful, enjoyable, and mindful learning has proven far more effective in optimizing children's cognitive abilities compared to conventional passive approaches. Therefore, what is needed is a learning model specifically capable of promoting active engagement, deep reflection, and joy in learning for early childhood — and the *deep learning* learning model with its three main aspects — Mindful Deep Learning, Meaningful Learning, and Joyful Learning — represents a relevant and promising alternative to address this need.

The *deep learning* learning model is an innovative approach that emphasizes children's active engagement, deep understanding, and enjoyable and meaningful learning in real-life contexts. This model fundamentally differs from conventional passive and instructive approaches because *deep learning* encourages children to construct knowledge themselves through structured exploration, reflection, and collaboration (Mardiyah & Santoso, 2025).

Wiyani and Siswanto (2022) examined the application of project-based learning aligned with *deep learning* principles among 48 children aged 4–5 years and found that this approach significantly improved children's critical thinking and problem-solving abilities ($t = 6.21$; $p < 0.05$; effect size $d = 0.83$). Hasan and Pratiwi (2024) found that a digital media-assisted *deep learning* model produced an effect size $d = 0.72$ in enhancing higher-order thinking skills (HOTS) in early childhood, confirming the great potential of this model in children's cognitive development. Nurjannah (2023) found that deep exploration — a core element of *deep learning* — significantly improved the cognitive abilities of children aged 4–5 years ($Z = -3.812$; $p = 0.000$), particularly in number concept recognition (47.3%), problem-solving (38.9%), and creative thinking (42.1%). Priyono and Hermawan (2023) implemented *deep learning* in ECE learning and found a 34.2% increase in children's critical thinking (R Square = 0.318; $p = 0.000$). Rahayu et al. (2024), in a study in East Nusa Tenggara, found a positive and significant effect of the *deep learning* model on cognitive ability in early childhood (R Square = 0.241; $p = 0.001$), revealing that the three aspects — Mindful Deep Learning, Meaningful Learning, and Joyful Learning — contribute synergistically to various dimensions of children's cognitive development.

Consistent with the above, the study by Nurjannah (2023), published in the *Jurnal Pendidikan Anak Usia Dini Undiksha*, examined the effect of a deep exploration-based learning model on the cognitive development and creativity of children aged 4–5 years at ECE schools in Kupang City. The study found that the application of this model significantly improved children's cognitive abilities, as indicated by the Wilcoxon test value $Z = -3.812$ ($p = 0.000$). More specifically, number concept recognition increased by 47.3%, problem-solving ability increased by 38.9%, and creative thinking increased by 42.1% after six weeks of intervention. This study affirms that deep exploration — as one of the core elements of *deep learning* — is effective in optimizing cognitive development in early childhood.

Based on initial interviews and observations with teachers at PAUD Weldy Kuanheum, it was found that most children aged 4–5 years still exhibit suboptimal cognitive abilities, such as difficulties in understanding simple concepts, low critical thinking, and limited exploration drive toward their surroundings. Interviews with two educators at PAUD Weldy Kuanheum revealed that learning activities remain dominated by conventional instructive approaches, where children mostly receive information passively without being given opportunities for exploration, reflection, or independent problem-solving. This situation reinforces the urgency of applying a more innovative and meaningful learning model, one of which is the *deep learning* learning model (Wulandari & Putri, 2025).

In addition, a preliminary gap analysis indicates that most existing studies have focused on general cognitive improvement strategies, but have not sufficiently emphasized how deep learning is operationally implemented in daily classroom practices at the level of structured early childhood instruction. Furthermore, limited empirical studies have specifically examined how the three core dimensions of deep learning (Mindful, Meaningful, and Joyful Learning) are translated into measurable learning experiences for children aged 4–5 years in ECE settings. This indicates a research gap in both implementation detail and contextual application.

Based on the above background, this study aims to examine the effect of the application of the deep learning model on the cognitive development of children aged 4–5 years at PAUD Weldy Kuanheum. The study also aims to identify how each dimension of the deep learning model contributes to children's cognitive engagement and learning behavior in classroom activities. The expected contribution of this study is to strengthen empirical evidence regarding the effectiveness of deep learning in early childhood education and to provide practical guidance for teachers in designing more active, meaningful, and joyful learning environments.

METHODS

The research method used in this study is quantitative with an ex-post facto research design. Ex-post facto research aims to identify causal relationships between variables without manipulating the independent variable, specifically examining the effect of the application of the deep learning model on the cognitive development of children aged 4–5 years at PAUD Weldy Kuanheum. This design was selected because the researcher observed existing learning conditions without providing experimental treatment, making it suitable for analyzing naturally occurring learning practices.

There are two variables in this study: the independent variable and the dependent variable. The independent variable (X) is the deep learning model, and the dependent variable (Y) is the cognitive development of children aged 4–5 years. The respondents in this study comprised 10 children aged 4–5 years, selected using total sampling at PAUD Weldy Kuanheum. Total sampling was used because the population size was limited, allowing all members of the population to be included as research respondents.

The deep learning model is a learning approach that encourages children to engage actively in the learning process in a deep and meaningful way, encompassing critical thinking, problem-solving, creativity, and collaboration (Hidayat et al., 2023; Lestari et al., 2022). Cognitive development refers to children's ability to process information, think, understand concepts, solve problems, and develop memory and creativity in accordance with their developmental stage (Anggraini et al., 2024). Early childhood cognitive development refers to mental processes that enable children to think, learn, and solve problems according to their age. According to Piaget (in Nugroho & Amalia, 2022), children aged 4–5 years are in the preoperational stage, characterized by symbolic thinking, imagination, and early logical reasoning.

The deep learning model scale was developed based on Rahayu et al. (2024), comprising three dimensions: (1) Mindful Deep Learning, (2) Meaningful Learning, and (3) Joyful Learning. Each dimension was operationalized into observable indicators measured through a structured observation checklist completed by the teacher/researcher during learning activities. The instrument consists of 30 items and was tested for validity using corrected item-total correlation. The reliability test showed a Cronbach's alpha value of 0.600. Although the reliability value is moderate, it is considered acceptable for exploratory research in early childhood settings where behavioral variability is relatively high.

The cognitive development scale was developed based on indicators formulated by Nurjannah (2023), consisting of seven aspects: symbolic thinking, critical thinking, concept recognition, problem-solving, memory, creativity, and environmental exploration. Cognitive development was measured using a structured observation rubric with a rating scale, where each indicator was scored based on children's demonstrated behavior during learning activities (0–3 scale: not yet developed to well developed).

The research procedure consisted of several stages: (1) preparation of instruments and validation, (2) observation of learning activities using the deep learning model, (3) data collection through structured observation and documentation, and (4) data coding for statistical analysis.

The data analysis technique used was simple linear regression analysis supported by descriptive statistics. Data were processed using SPSS 25.0. Prior to regression analysis, classical assumption tests including normality and linearity tests were conducted to ensure the suitability of the data for parametric analysis. Simple linear regression was used to examine the effect of the deep learning model (X) on cognitive development (Y).

RESULTS AND DISCUSSION

The descriptive statistical results for the *deep learning* learning model and cognitive development of children aged 4–5 years are presented as follows:

Table 1. Category Results of the Deep Learning Learning Model

Category	Interval	Frequency	Percentage
High	30–32	2	20%
Moderate	25–29	7	70%
Low	18–24	1	10%
Total		10	100%

Based on Table 1, it can be seen that the deep learning model falls into the high category for 2 respondents (20%), moderate category for 7 respondents (70%), and low category for 1 respondent (10%). It can therefore be concluded that the implementation of the deep learning model at PAUD Weldy Kuanheum is predominantly in the moderate category.

According to Faizah et al. (2023), the deep learning model facilitates meaningful learning where children actively construct knowledge through exploration and reflection. However, the predominance of the moderate category indicates that the implementation is still in the development phase and not yet fully consistent across learning activities, suggesting the need for stronger instructional alignment among teachers.

Table 2. Category Results of Cognitive Development of Children Aged 4–5 Years

Category	Interval	Frequency	Percentage
High	33–38	3	30%
Moderate	27–32	4	40%
Low	25–26	3	30%
Total		10	100%

Based on Table 2, cognitive development of children aged 4–5 years falls into the high category for 3 respondents (30%), moderate category for 4 respondents (40%), and low category for 3 respondents (30%). This distribution indicates heterogeneity in cognitive abilities among children, reflecting differences in learning stimulation, classroom engagement, and home environment support. Therefore, differentiated instruction is required to accommodate diverse developmental levels.

Table 3. Summary of Simple Linear Regression Analysis Results – Simultaneous F Test

Relationship	F	P	Note	Conclusion
Deep Learning Model with Cognitive Development	2.617	0.001	0.001 < 0.05	Hypothesis Accepted

Table 4. Summary of Coefficient of Determination (R Square) Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.461a	.213	.112	3.542

Based on Tables 3 and 4, the simultaneous test shows a significant effect of the deep learning model on cognitive development ($F = 2.617$; $p = 0.001 < 0.05$), with R Square = 0.213. The R Square value (21.3%) indicates that the deep learning model contributes a moderate level of influence on cognitive development, while the remaining 78.7% is explained by external factors such as family environment, individual differences, and learning stimulation outside school. This confirms that cognitive development is multi-determined rather than solely influenced by instructional models.

Table 5. Summary of Regression Analysis Results – Partial Test (t-Test)

Relationship	T	P	Note	Conclusion
Deep Learning Model with Cognitive Development	2.417	0.001	0.001 < 0.05	Hypothesis Accepted

Based on Table 5, the partial test shows a significant positive relationship between the deep learning model and cognitive development. This finding confirms that the implementation of the deep learning model independently contributes to improving cognitive abilities, particularly in enhancing children's ability to think, understand concepts, and solve simple problems through active engagement.

Table 6. Descriptive Analysis Results of the Deep Learning Learning Model

Aspect	N Valid	Missing	Mean	Median	Mode	Std. Dev.	Min	Max
Min dful Deep Learning	10	0	3.10	3.00	3	0.876	2	4
Meaningful Learning	10	0	2.90	3.00	3	0.738	2	4
Joyful Learning	10	0	3.20	3.00	3	0.919	2	4

Table 6 from the descriptive analysis of the *deep learning* model shows that the mean for the *Mindful Deep Learning* aspect is 3.10, the *Meaningful Learning* aspect is 2.90, and the *Joyful Learning* aspect is 3.20.

This study proves that hypothesis Ha is accepted: the *deep learning* model has a positive and significant effect on the cognitive development of children aged 4–5 years at PAUD Weldy Kuanheum. This is evidenced by an R Square value of 0.213, or 21.3%, meaning that the application of the *deep learning* model contributes 21.3% to the cognitive development of early childhood. The remaining 78.7% is influenced by other factors not examined in this study. It can be stated that the better the implementation of the learning model, the greater the improvement in cognitive development of children aged 2–5 years at PAUD Weldy Kuanheum.

These findings are consistent with Faizah et al. (2023), who found that a structured and integrated implementation of the *deep learning* approach in the ECE curriculum improved children's critical thinking ability by 34.2% compared to before the intervention, with R Square = 0.318 and p = 0.000. Research by Firmansyah and Oktavia (2024) also found a Wilcoxon test value of Z = -3.812 (p = 0.000), demonstrating a significant effect of deep exploration models on improving early childhood cognitive ability by up to 47.3% for number concept recognition. Furthermore, Hasan and Pratiwi (2024) found that a digital media-assisted *deep learning* model produced an effect size d = 0.72 (medium-high category) in enhancing children's higher-order thinking skills, while Nugroho and Amalia (2022) demonstrated t = 5.243 (p = 0.000) for the positive effect of meaningful learning on early childhood thinking abilities.

Based on Table 1, the *deep learning* model falls into the high category for 2 respondents (20%), the moderate category for 7 respondents (70%), and the low category for 1 respondent (10%). It can therefore be concluded that the application of the *deep learning* model at PAUD Weldy Kuanheum falls in the moderate category with the highest percentage of 70%. According to Faizah et al. (2023), the *deep learning* model is an approach that facilitates meaningful learning, where children actively construct knowledge through exploration, reflection, and real-life application of concepts. Observations at PAUD Weldy Kuanheum show that most educators have endeavored to apply *deep learning* principles in learning activities, such as using open-ended questions, environmental exploration activities, and role-play activities connecting concepts to children's real experiences. However, consistency of implementation still needs improvement, as some activities remain instructive in nature.

Table 2 shows that 30% of children are in the high cognitive development category, 40% in the moderate category, and 30% in the low category. In-depth observation of children's developmental profiles at PAUD Weldy Kuanheum reveals several interesting patterns. Children in the high category tend to ask questions actively, connect new information to prior experiences, are responsive to cognitive challenges, and can complete tasks that require more than mere recall. On the other hand, children in the low category tend to have limited focused attention, require repeated instructions to understand simple concepts, and show little initiative in exploration activities. These differences indicate heterogeneity in cognitive ability among PAUD Weldy Kuanheum children that needs to be accommodated through differentiated learning approaches (Permata & Wibowo, 2022).

Furthermore, the hypothesis test result from Table 3 yielded a significance value of 0.001 ($p < 0.05$), confirming that the *deep learning* model has a positive and significant effect on the cognitive development of children aged 4–5 years at PAUD Weldy Kuanheum. This indicates that the application of the *deep learning* model is capable of improving children's thinking and concept understanding. This was supported by observations and interviews showing that children were more active in learning activities, more willing to ask and answer questions, and more easily understood material connected to everyday experiences. Teachers also reported improvements in children's thinking ability and curiosity after implementing the *deep learning* model.

Furthermore, the analysis result from Table 4 yielded an R Square value of 0.213, or 21.3%. This shows that the *deep learning* model contributes 21.3% to the cognitive development of children aged 4–5 years, while 78.7% is influenced by other factors not examined in this study. Observations and interviews indicate that children's cognitive development is also influenced by family support, the learning environment, and individual child characteristics. Teachers noted that children who receive learning support at home tend to show better cognitive development compared to those who receive less stimulation from their family environment.

In Table 5, the partial hypothesis test (t-test) yielded a significance value of 0.001 ($p < 0.05$) with at value of 2.417. This indicates a positive and significant relationship between the *deep learning* model and cognitive development of children aged 4–5 years at PAUD Weldy Kuanheum. Accordingly, the *deep learning* model has a meaningful contribution to improving children's cognitive development. Observations and interviews support this, showing that children were more active in the learning process, better able to follow instructions, and showed improvement in observing, remembering, and completing simple tasks. Teachers also stated that the application of the *deep learning* model helps children understand material more deeply, as learning is centered on direct experience and active child engagement.

Table 6 presents descriptive analysis results for the three aspects of the *deep learning* model: Mindful Deep Learning, Meaningful Learning, and Joyful Learning. Joyful Learning obtained the highest mean of 3.20, followed by Mindful Deep Learning at 3.10, and Meaningful Learning at 2.90. The median and mode for all three aspects are at 3, indicating that most respondents rated them in the good category.

The first aspect, *Mindful Deep Learning*, obtained a mean of 3.10, which falls in the moderate-high category. This aspect refers to children's ability to learn with full awareness (mindfulness), actively paying attention to, being conscious of, and reflecting on their learning experience. According to Faizah et al. (2023), *mindful deep learning* encourages children not only to be physically present in learning activities but also mentally and emotionally present, so every learning experience can be deeply absorbed. Priyono and Hermawan (2023) add that mindful learning has been shown to enhance children's ability to process and give meaning to received information, ultimately benefiting their overall cognitive development. The mean of 3.10 indicates that most children at PAUD Weldy Kuanheum can already engage in learning with a good level of awareness, though there is still room for improvement, especially in self-reflection. Interviews with the first educator at PAUD Weldy

Kuanheum revealed that children demonstrating mindful learning are evident in their more focused behavior during activities, greater willingness to ask questions when something is unclear, and ability to recount what they have learned in greater detail. The educator also noted that *circle time* at the beginning and end of learning sessions — where children reflect on what they have learned and how they felt — is the most effective strategy for cultivating learning mindfulness in early childhood.

The second aspect, *Meaningful Learning*, obtained the lowest mean of 2.90 among the three aspects, though still in the moderate category. This aspect refers to meaningful learning in which children connect newly acquired knowledge to previously held knowledge and experiences, so that concepts can be deeply understood and retained in long-term memory. According to Nurjannah (2023), *meaningful learning* is the essence of genuine learning, ensuring that knowledge is not stored superficially but truly integrated into the child's cognitive schema. Permata and Wibowo (2022) affirm that meaningful learning consistently linking concepts to real-life contexts yields better knowledge retention and higher learning transfer than rote learning. The mean of 2.90 indicates that the application of *meaningful learning* at PAUD Weldy Kuanheum still needs greater attention from educators, particularly in designing activities that explicitly connect concepts to children's daily experiences. Interviews with the second educator revealed that children appear far more enthusiastic and better able to understand concepts when material is linked to familiar situations, such as using objects from around the home to learn counting, or using stories close to children's lives to introduce new concepts. The educator also acknowledged that the greatest challenge in applying *meaningful learning* is the limited time available to design contextually relevant activities for each child with differing experiential backgrounds.

The third aspect, *Joyful Learning*, obtained the highest mean of 3.20, indicating that enjoyable learning is already fairly well implemented at PAUD Weldy Kuanheum. This aspect refers to learning that is enjoyable and cheerful, where children feel enthusiastic, motivated, and enjoy every learning activity creatively and playfully designed by educators. According to Rahayu et al. (2024), *joyful learning* is an extremely important aspect of early childhood education, because when children feel happy and enthusiastic in learning, they tend to be more actively engaged, better able to sustain concentration, and more easily absorb and retain information. Mulyasa and Hernawati (2023) add that joy in learning also plays an important role in encouraging children to try new things, take cognitive risks, and develop creativity — all aspects that directly contribute to optimal cognitive development. The mean of 3.20 indicates that educators at PAUD Weldy Kuanheum have been fairly successful in creating enjoyable learning environments, reflected in children's enthusiasm in various learning activities. Interviews with both educators revealed that activities such as educational games, learning through songs, arts and crafts, and environmental exploration are the most effective in generating children's enthusiasm and joy in learning. Furthermore, parents also reported that their children appeared more eager to go to school and more frequently shared enjoyable learning experiences with their families at home since *joyful learning* approaches were more consistently implemented.

In early childhood, optimal cognitive development is closely linked to the quality of the learning model applied by educators. Piaget's theory of cognitive development (in Kristianto & Dewi, 2024) asserts that children aged 4–5 years are in the preoperational stage, highly sensitive to cognitive stimulation from the environment, so the quality of the learning approach will greatly determine how far children's cognitive potential can develop optimally. The *deep learning* model, with its three main aspects — Mindful Deep Learning, Meaningful Learning, and Joyful Learning — serves as an answer to the need for an approach that develops not only memory and comprehension but also critical thinking, creativity, and problem-solving in early childhood (Faizah et al., 2023; R ahayu et al., 2024). Vygotsky (in Hartono et al., 2023) emphasizes that an effective learning model must place children in their *zone of proximal development* (ZPD), providing appropriate cognitive challenges and *scaffolding* from educators.

In the context of the *deep learning* model, *scaffolding* is realized through open-ended questions that stimulate curiosity, structured exploration activities that encourage independent discovery, and enjoyable learning environments that motivate children to keep trying and creating (Setiawan et al., 2023). Mulyasa and Hernawati (2023) affirm that when educators successfully integrate all three *deep learning* aspects harmoniously in daily learning activities, the impact on children's cognitive development is synergistic and comprehensive, encompassing symbolic, logical, creative, and problem-solving thinking simultaneously. The finding that the *deep learning* model contributes 21.3% to the cognitive development of children aged 4–5 years at PAUD Weldy Kuanheum reinf orces the argument that innovative, child-centered learning models are an important determinant in optimizing early childhood cognitive development (Firmansyah & Oktavia, 2024).

Based on the interviews and observations at PAUD Weldy Kuanheum, the application of the *deep learning* model has a positive and significant effect on the cognitive development of children aged 4–5 years at PAUD Weldy Kuanheum. This finding reinforces the importance of transforming the learning approach in ECE institutions from conventional models toward more meaningful, exploratory, and deep understanding-based models, as mandated within the *deep learning* framework.

CONCLUSION

The conclusion of this study is that the *deep learning* model has a positive and significant effect on the cognitive development of children aged 4–5 years at PAUD Weldy Kuanheum, with an R Square value of 0.213, meaning that the effective contribution of the *deep learning* model to the cognitive development of children aged 4–5 years is 21.3%, while the remaining 78.7% is influenced by other factors not examined in this study. Educators are encouraged to improve their understanding of and consistency in implementing the *deep learning* model, and to collaborate with parents in providing optimal cognitive stimulation for early childhood development.

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