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The Implementation of Ai-Based English Learning in Early Childhood Education

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ABSTRACT

The swift growth of digital technology has heightened the urgency of learning English from an early age, especially with the emergence of Artificial Intelligence (AI) technology, which offers a highly adaptive, interactive, and customized learning experience for children. This study aims to explore the implementation of AI-based English lessons in early childhood education and understand the experiences of teachers and children in the process of integrating it into the classroom. This approach uses a qualitative method with a phenomenological design, which focuses on the direct experiences of the participants. Data was obtained through participant observation, in-depth interviews, and documentation. The findings revealed four main themes: (1) Forms of AI-Based Implementation, including the use ofAI applications such as AI storytelling, pronunciation applications, andlearning flows consisting of introduction, interaction, and feedback stages; (2) Children's Engagement and Learning Responses, which included enthusiasm, curiosity, active participation, and improvement in vocabulary and pronunciation skills; (3) Teachers' Pedagogical Adaptation, namely the evolving role of teachers as facilitators and designers of AI-based play activities; and (4) Technical constraints, variations in teachers' digital competencies, and concerns regarding screen time. These findings confirm that AI can be meaningfully integrated into early childhood English language learning when combined with a play-based approach appropriate to the child's developmental stage and supported by adequate teacher competency. This study has pedagogical and practical implications, including the need for ongoing teacher training, the development of school policies regarding the safe use of technology for children, and the strategic integration of AI and play-based learning.

Keywords: Artificial Intelligence, Early Childhood Education, English Language Learning, Qualitative.

INTRODUCTION

The significant growth of Artificial Intelligence (AI) technology in recently years has brought about significant changes to various educational practices, including early childhood education. Various AI innovations, such as intelligent tutoring systems, speech recognition, adaptive learning, and game-based learning applications, are now being utilized to enhance children's learning experiences (Shidiq, 2023). Steiss et al. (2024) added that this technology enables personalized learning, immediate feedback, and the provision of a more interactive and enjoyable learning environment. With these capabilities, AI is considered a great way to promote English learning in childhood.

On the other hand, early exposure to English is an important foundation for the development of children's linguistic abilities. Various language development studies show that early childhood is a critical period, during

which children need rich language input, meaningful interactions, and multisensory learning experiences (Levine et al., 2025). However, many Early Childhood Education (PAUD) institutions, especially in developing countries, still face various obstacles in providing effective English language learning. Limited time, lack of teacher competence in English, and lack of interesting learning resources are often the main obstacles that hinder consistent language exposure for children.

In view of these challenges, the integration of AI technology offers innovative solutions to enrich the English learning experience for children aged 4–6 years. Yunita et al. (2025) highlight that AI applications such as interactive storytelling, vocabulary learning chatbots, and pronunciation tools can provide personalized language input, support play-based learning, and help children practice independently. However, the implementation of artificial intelligence (AI) in the concept of Early Childhood Education (PAUD) should not be done carelessly. A deep understanding of the suitability of technology with the characteristics of child development, teacher readiness, and classroom learning dynamics is required to ensure that its implementation truly provides pedagogical benefits (Scanlon et al., 2011).

Based on this background, this investigation was designed to respond to the following research questions: (1) how artificial intelligence (AI)-based English language learning is implemented in early childhood education institutions; (2) what are the thoughts and behaviors of teachers in using AI for English teaching; (3) how do children respond and participate in AI-supported learning activities; and (4) what obstacles arise during the implementation process. In line with these research questions, this investigation seeks to describe in depth the implementation of AI in English language learning in early childhood education, identify teachers' experiences and perceptions of its use, analyze children's engagement and responses when interacting with AI technology, and explain the various obstacles encountered and possible solutions.

Based on prior work, studies on the application of artificial intelligence (AI) in education have generally focused on primary, secondary, and higher education levels. Meanwhile, there is limited investigation into embedding AI in early childhood contexts, particularly concerning English language learning. Few studies have specifically developed AI implementation models tailored to the characteristics of 4–6-year-olds. Therefore, this present study aims to fill this void by giving an empirical description of AI-based English language learning experiences in young learners' contexts.

On the whole, this study has several important contributions. Theoretically, this study enriches the landscape of research literature on the utilization of artificial intelligence (AI) in language learning during childhood. Practically, the results of this study provide recommendations for teachers, principals, and policymakers regarding effective strategies, potential challenges, and best practices in integrating AI into English teaching. From the perspective of technology, the findings of this paper can also be a reference for application developers to design or customize AI products that are more child-friendly and in line with the pedagogical needs of early childhood education.

LITERATURE REVIEW

AI in Early Childhood Education

Artificial Intelligence (AI) is a technology that enables computer systems to mimic human thought processes, such as recognizing patterns, making decisions, and providing intelligent responses automatically. Darwin et al. (2024) stated that in the context of education, AI is used to create learning experiences that are more adaptive, responsive, and personalized to the needs of learners. In early childhood education, AI is being implemented through various forms of technology designed to support children's cognitive and language development (Rozimela et al., 2025). Some types of AI that are relevant for children aged 4–6 years include speech recognition, interactive storytelling, adaptive vocabulary applications, and gamification-based AI (Gayed et al., 2022). Speech recognition technology helps children practice pronunciation and speaking directly, while interactive storytelling allows children to listen to interactive stories that can respond to their choices or questions. Adaptive vocabulary applications provide exercises tailored to children's abilities and development, while AI-based gamification models present learning in the form of engaging games that increase children's involvement.

The integration of AI in early childhood education not only offers a more engaging learning experience but also provides opportunities for teachers to facilitate more meaningful learning (Kostka & Toncelli, 2023). However, its use must still take into account pedagogical principles and child development so that technology can function as a supporting tool, not a substitute for human interaction.

Principles of English Language Learning for Early Childhood

Early childhood English language learning has different characteristics and principles compared to learning at higher levels. Young children learn through imitative learning, where they naturally mimic the sounds, intonations, and expressions of the language from their surroundings (Marshall, 2007). Repetition is an important element in learning, as children need repetition to reinforce their understanding and form linguistic habits. In addition, children learn optimally when given multimodal input such as visual, audio, movement, and direct interaction (Chapelle & Sauro, 2017). Play-based learning is also a key principle, as children find it easier to understand language concepts through fun and meaningful play activities.

The stages of language development in children aged 4–6 years show that they begin to be able to understand simple instructions, develop basic vocabulary, and express their ideas in short sentences (Wahyuningsih & Affandi, 2020). At this stage, rich, interactive, and contextually appropriate English input is very important to support phonological, vocabulary, and language comprehension development. Therefore, the technology used must be responsive, safe, and appropriate for the developmental characteristics of children.

AI for English Language Learning

Recent studies from Da-Eun Han (2020) demonstrate that artificial intelligence (AI) has a potential positive impact on the learning of English for children and beginners. Madhavi et al. (2023) highlight that these studies found that the use of AI can increase children's vocabulary, improve pronunciation through speech recognition, and increase their motivation to learn through educational games and engaging interactions. AI also provides the advantage of immediate feedback so that children can quickly identify pronunciation or comprehension errors. In addition, AI's ability to adjust the level of difficulty of the material to individual abilities makes it an effective tool for personalizing learning (Mahapatra, 2024).

Despite its many advantages, several limitations have also been identified. One of them is the dependence on devices and a stable internet connection. In addition, the successful use of AI greatly depends on the readiness of teachers to operate the technology (Levine et al., 2025). Low technological competence can hinder the optimal use of AI in the classroom. Therefore, training support for teachers is an important aspect of the implementation of AI in language learning.

Challenges of Implementing AI in Classrooms

The implementation of AI in the context of early childhood education is not without challenges that need to be considered. One of the main challenges is teacher readiness, particularly in relation to digital literacy (Huang & Zou, 2024). Many early childhood teachers are still unfamiliar with integrating advanced technology into learning, requiring intensive training. Other challenges relate to school infrastructure, such as limited devices, unstable internet networks, or minimal access to quality AI applications.

Screen time is also an important issue in the implementation of technology for young children. Hidayatullah (2024) argues that the use of AI must take into account appropriate time limits so as not to interfere with children's social-emotional and physical development. In addition, data privacy and child safety are serious considerations, given that AI-based applications often require access to user data, including children's voices or activities. Therefore, the selection of AI applications must take into account security standards, data protection, and the suitability of content for children's ages.

METHOD

This paper uses a qualitative approach with a phenomenological design because the main focus of the study is to deeply understand the authentic experiences of teachers, principals, and parents in implementing artificial intelligence (AI)-based English language learning in early childhood (Verleye, 2019) & (Bailey, 2019). This design was chosen to capture the meanings, perceptions, and pedagogical dynamics that emerged during the learning process, thereby providing a comprehensive picture of how AI technology is used, responded to, and evaluated by ECE practitioners in a real-world context. The research was conducted at an Early Childhood Education institution that has integrated AI applications into English language learning activities, with the selection of locations and participants carried out using purposive sampling techniques. Participants consisted of classroom teachers (T), assistant teachers (AT), school principals (SP), and several parents (P) who were considered to have in-depth insights into the phenomenon being studied.

Data were gathered through direct observation, in-depth interviews, and documentation. Observations were conducted to examine the implementation of artificial intelligence (AI) technology in the learning process, particularly how children interact with voice-based applications, word recognition, or educational games. In-depth interviews were used to obtain the perspectives of teachers, principals, and parents regarding the benefits, challenges, and changes in children's behaviour or motivation while participating in AI-based learning. Documentation, in the form of photos of activities without identifying children, learning tools, and lesson plans

or learning outcomes, was used to reinforce field data findings. All collected data were analysed using Braun and Clarke's Thematic Analysis, which consists of six stages: data familiarization, initial coding, theme identification, theme review, theme naming, and narrative report writing (Clarke & Braun, 2017).

To confirm the authenticity of the data, this study employed triangulation and participant techniques checking so that the researcher's interpretations could be validated by the participants. Transferability was maintained by providing thick descriptions of the school context and learning process. Dependability was strengthened through the preparation of an audit trail as evidence of a systematic research process, while confirmability was achieved through the researcher's reflexivity to minimize personal bias. The entire research process was carried out in accordance with applicable research ethics, including obtaining written consent from parents, maintaining the confidentiality of children's identities, and ensuring the security of all recorded data and research documents. Thus, this methodology was designed to produce credible, transparent, and accountable findings.

FINDING AND DISCUSSIONS

This section discusses and interprets the research findings by relating them to child development theory, language learning principles, and the latest literature on the use of Artificial Intelligence (AI) in early childhood education. The findings from the thematic analysis provide a comprehensive picture of how AI is implemented in English language learning, how children respond to it, how teachers adapt their pedagogical practices, and the challenges that arise during the process. Thus, this discussion not only serves to explain the correlation of the findings and the theoretical framework but also critiques the findings through the perspective of research from 2021 to 2025, thereby providing relevant scientific contributions and pedagogical implications. This in-depth analysis is expected to strengthen the argument that the Implementation of AI in early childhood is a promising practice, but still requires regulation, assistance, and the readiness of the educational ecosystem as a whole.

Theme 1: Forms of AI-Based Implementation

Participant	Sample Quote	Interpretation / Insight
T1	"Children love AI storytelling the most. They immediately sit up straight as soon as the characters start talking."	AI storytelling is effective as *an attention grabber* and increases *situational engagement* from the start of learning.
T3	"The pronunciation app is very helpful because it immediately gives right or wrong answers, so children know where they need to repeat."	Automatic feedback from AI serves as an instant *formative assessment,* which is difficult for teachers to do individually.
T2	"I usually start with an introduction to the words, then the children interact with the app, and finally we discuss the results together."	Teachers apply the pattern *of introduction, interaction, and feedback*, demonstrating systematic pedagogical integration.
T4	"AI helps me save time on drilling. I can focus on assisting each child individually."	AI acts as *a co-teacher* that supports time efficiency and enables teachers to differentiate.

The findings show that AI is implemented through storytelling, pronunciation exercises, and automatic feedback, all of which contribute significantly to the English learning process in early childhood education. Teacher 1 emphasized that "children like AI storytelling the most... as soon as the characters start talking, they immediately sit down neatly." This shows that AI storytelling serves as an attention grabber and is able to increase children's situational engagement from the start of the activity. These findings are in line with Mayer's (2002) Multimedia Learning theory, which states that multimodal (audio-visual) narratives can increase attention and retention, especially in early learners who are highly responsive to story stimuli. However, Vygotsky's theory reminds us that high engagement does not necessarily mean deep understanding; social interaction remains crucial for making sense of content.

In addition, AI is also used for pronunciation practice that provides instant feedback. Teacher 3 explained that the application "immediately gives right or wrong answers, so children know where they need to repeat." This confirms the function of AI as automatic formative assessment, consistent with Huang & Zou, (2024) view that immediate feedback is the key to improving phonological skills. However, according to the theory of early childhood phonological development (Kuhl, 2021), digital feedback must still be accompanied by human modelling, because young children learn phonology through human interactions that are rich in expression and prosody.

The integration of AI in the classroom also appears systematic. Teacher 2 demonstrated a pattern of introduction, interaction, feedback, reflecting the constructivist learning cycle model, and guided participation. This is in line with the TPACK framework (Mishra & Koehler, 2006), which emphasizes that the success of technology does not lie in the tools themselves, but in how they are integrated with content and pedagogy. However, overly structured application-based integration has the potential to reduce children's spontaneity in exploration, which, according to the theory of developmentally appropriate practice (Sanders & Farago, 2018), is at the core of early childhood education.

Other findings show that AI also functions as a co-teacher. Teacher 4 stated that "AI helps save time on drilling... I can focus on accompanying each child individually." This supports the theory of AI-augmented teaching, Eager & Brunton (2023), which states that technology can take over repetitive tasks, allowing teachers to focus on individual learning differentiation. However, critical literature emphasizes that over-reliance on AI can reduce teachers' sensitivity to children's soft cues of development, which is an essential aspect in early childhood education settings.

Overall, the forms of AI implementation found not only increased efficiency and engagement but also changed the way teachers managed their classrooms and provided individual support. However, child development theories emphasize that AI should be positioned as a support, not a substitute, for warm and responsive pedagogical relationships, so that the use of technology remains in line with early childhood learning principles.

Theme 2: Children's Engagement and Learning Response

Participant	Sample Quote	Interpretation / Insight
OBS 2 (Classroom Observation)	"The children cheered when the AI gave a round of applause after they said the word correctly."	Digital rewards increase intrinsic motivation, supporting the theory of *gamified engagement* (Kim, 2024).
T1	"Some children asked to repeat the word until the AI said, 'Great job.' They were eager to try again."	Children demonstrated *self-directed repetition*, which is important in *imitative learning* (Bruner, 2021).
T5	"Their vocabulary is growing rapidly. Words like 'apple,' 'tiger,' and 'run' are becoming clearer in pronunciation."	AI improves *vocabulary retention* and *pronunciation accuracy*, according to the 2021–2025 research on AI–ELL.
OBS 3	"Children work together to hold the device and imitate the AI's sounds together."	Social interaction occurs naturally, supporting the concept of *collaborative learning* in early childhood.

Observations show that the implementation of AI in early childhood education not only affects children's language achievement but also changes their interaction patterns, motivation, and learning behaviour. In classroom observations, children were seen "cheering when the AI clapped after they pronounced a word correctly." This indication shows that digital rewards can increase children's intrinsic motivation and focus, in line with the concept of gamified engagement proposed by Cha & Tang (2024), where game elements such as audio praise and animation can encourage children to engage more actively. However, according to the theoretical critique by Deci & Ryan (Self-Determination Theory), excessive use of digital rewards has the potential to shift intrinsic motivation to extrinsic motivation, so their use must remain measured.

Other findings reinforce the pattern of self-directed repetition. Teacher 1 explained that "some children ask to repeat words until the AI says 'great job'," indicating that children are motivated to improve their results without direct instructions from the teacher. This is in line with Bruner's (2021) concept of imitative learning, in which children learn language through repetition triggered by attractive and predictable behavioural models. AI, with its consistent voice and immediate assessment system, serves as a stable imitation model. However, criticism from the language development literature notes that more varied and expressive human intonation remains richer than the sometimes-monotonous voice of AI, so teachers still need to be present as the primary phonological model.

From a language development perspective, Teacher 5 noted that "their vocabulary grew rapidly... their pronunciation was also clearer." This finding is consistent with various studies from 2021–2025 showing that AI systems, through adaptive repetition and immediate corrective feedback, can improve vocabulary retention and pronunciation accuracy in early learners. This also emphasizes the importance of structured language exposure and opportunities for repeated production. However, the theory of early childhood language acquisition (Kuhl, 2014) reminds us that successful vocabulary improvement depends not only on the frequency of digital practice, but also on the quality of the accompanying social interactions.

Another important aspect that emerged was that AI actually encouraged social interaction among children. In another classroom observation, children were seen "working together to hold the device and imitate the AI's voice

together." This shows that the use of technology is not always individualistic; on the contrary, it can naturally trigger collaborative learning. These findings support Vygotsky's view that children's learning is greatly influenced by social activities and shared attention. However, early childhood education theory warns that healthy collaborative interactions must be guided so that they do not turn into competition for devices, which often occurs in early childhood education classes when technology is introduced without structure.

Overall, these findings show that AI implementation not only strengthens vocabulary and pronunciation mastery but also triggers motivation, independent repetition, and social interaction. However, literature on child development emphasizes that the usefulness of artificial intelligence (AI) is highly dependent on the role of teachers in guiding the use of technology to maintain a balance between digital motivation, human modeling, and meaningful social interaction.

Theme 3. Teacher's Pedagogical Adaptation

Participant	Sample Quote	Interpretation / Insight
T2	"I still start with physical games before using AI, so that children are not fixated on the screen."	Teachers maintain a balance *between screen and non-screen activities* in accordance with the principles of early childhood development.
T3	"I incorporate AI into the play center, so children take turns based on their play groups."	The integration of AI into *play-based learning* demonstrates planned pedagogical adaptation.
T4	"I have to learn new features every week so I can explain them to the children."	Teachers act as *lifelong learners* in the era of AI Education.
T1	"My role has changed. I used to talk a lot, but now I spend more time guiding."	The shift from *teacher-centered* to *facilitator-centered teaching* strengthens pedagogical transformation.

Research findings show that teachers engage in various forms of pedagogical adaptation to ensure that AI integration remains appropriate for the developmental characteristics of young children. Teacher 2 emphasized that "I still start with physical games before using AI, so that children don't just stare at the screen." This statement shows the teacher's efforts to maintain a balance between digital and motor activities. This approach is in line with the principle of developmentally appropriate practice (DAP), which emphasizes the importance of varied activities and experiential learning (Hanna Kang, 2022). However, early childhood education literature also criticizes that this balance is often difficult to maintain in classrooms with limited devices, so strategies such as those implemented by T2 need to be supported by clear school policies on safe screen time proportions for children.

Teachers also integrate AI into play-based learning models, as exemplified by T3, who stated, "I make AI part of the play centre, so children take turns according to their play groups." This approach shows that teachers do not merely view AI as an additional tool but incorporate it into established pedagogical structures. This is in line with the theory of digital play (Edwards at. al, 2025), which states that technology can enrich the play experience when used purposefully and linked to social activities. However, recent research reminds us that the integration of digital play requires clear regulation so that it does not displace traditional play, which is richer in sensorimotor experiences.

Other findings indicate that teachers must continue to learn independently to keep up with developments in AI features. Teacher 4 said, "I have to learn new features every week so I can explain them to the children." This shows that teachers act as lifelong learners, where teachers are empowered to continue to develop and make appropriate pedagogical decisions in changing situations. However, educational literature criticizes that improving teacher competence cannot rely entirely on individual initiative; systematic training from educational institutions must be an integral part, so that adaptation does not occur sporadically.

The changing role of teachers is also evident in statement T1: "My role has changed. I used to talk a lot, but now I accompany them more." This shows a shift from teacher-centered learning to facilitator-centered learning, which is at the core of the modern 21st-century learning paradigm (Kostka & Toncelli, 2023). With AI taking on some of the instructional roles, such as drilling, pronunciation checking, and vocabulary introduction, teachers can focus more on mentoring, observing, and providing personal support. However, according to socio-constructivist theory (Vygotsky), teacher mentoring must remain active and cannot be completely replaced by technology, as the quality of human interaction remains a key component in children's language development.

Overall, the pedagogical adaptations made by teachers show that the implementation of AI in early childhood learning is not passive. Teachers strategically combine physical activities, games, mentoring, and digital learning to create balanced and meaningful learning. However, the literature emphasizes that the sustainability of these adaptations is highly dependent on institutional support, professional training, and clear guidelines for the implementation of technology in ECE.

Theme 4: Challenges Encountered

Participant	Sample Quote	Interpretation / Insight
T5	"The internet sometimes disconnects, so the story stops in the middle."	Digital infrastructure is a determining factor in the success of implementation.
T1	"I need time to really understand the features of AI. Not all teachers are comfortable with it."	Teachers' digital literacy is uneven; training is needed.
P2	"I'm concerned that children spend too much time looking at screens, even if it's for learning."	Screen time concerns align with AAP recommendations on screen exposure limits.
KS1 (School Principal)	"We don't have specific rules about the use of AI in the classroom yet."	The lack of clarity in policy indicates the need for child-friendly technology regulations.

Findings on the fourth theme show that the implementation of AI in early childhood education is not without various technical, pedagogical, and institutional challenges. The first challenge relates to digital infrastructure. Teacher 5 revealed that "the internet sometimes disconnects, so the story stops in the middle." This situation shows that network quality is a determining factor in the successful use of AI applications such as storytelling or pronunciation tools. This finding is in line with Huriati et al. (2023), which confirms that the success of educational technology in early childhood is greatly influenced by the stability and accessibility of digital infrastructure. Without adequate infrastructure support, AI risks hindering the learning process and reducing children's engagement. However, the literature also criticizes that dependence on the internet widens the digital divide between early childhood education institutions, especially in areas with limited access.

The second challenge arises from teachers' competence in understanding AI features. Teacher 1 stated that "I need time to really understand the features of AI. Not all teachers are comfortable with it." This illustrates the low level of digital literacy among early childhood education teachers. This finding report emphasizes that teacher digital readiness is the weakest component in the implementation of AI Education at the preschool level. Although teachers show a willingness to learn, the burden of independent adaptation without formal training can create pedagogical stress and reduce the quality of integration. The literature also emphasizes that training must be continuous, not a one-time event, so that teachers are able to utilize AI not only technically, but also pedagogically.

Additionally, concerns regarding screen time pose a unique challenge, particularly from parents. One parent (P2) expressed, "I am concerned that children spend too much time looking at screens, even if it is for learning." This concern emphasizes that screen exposure for young children should be limited and provided in the context of meaningful interaction. These findings indicate that even though AI is educational, its use must still be accompanied by proportional supervision and regulation. However, several recent studies Madhavi et al., 2023) criticize that the focus on "screen time limits" often ignores the quality of digital interactions. The challenge for early childhood education institutions is to balance duration and quality—not just reduce duration alone.

The final challenge relates to the lack of clear institutional policies. Principals (KS1) stated that "we don't have specific rules about the use of AI in the classroom." The lack of clarity in regulations indicates that technology integration is often done intuitively based on teachers' decisions, rather than institutional guidelines. This emphasizes the importance of AI governance in early childhood settings, including guidelines on child data protection, device usage proportions, and application selection standards. The absence of policies can lead to inconsistent practices and potentially violate child data privacy principles. Critical literature notes that schools that adopt technology without regulation tend to face greater risks related to security and ethical utilization of technology.

Overall, these challenges indicate that the successful implementation of AI in ECE is not only determined by applications or learning strategies, but also by infrastructure readiness, teacher competence, parental awareness, and the existence of institutional policies. This confirms that the application of AI in ECE is an ecosystem effort, not just a classroom innovation.

CONCLUSIONS

This research aims to understand the implementation of artificial intelligence (AI)-based English language learning in Early Childhood Education (PAUD) through a phenomenological qualitative approach. The findings show that AI has been integrated into various forms of learning media, such as AI storytelling, speech recognition, and pronunciation apps that allow children to receive multimodal input and direct feedback. Children's responses showed high levels of engagement, increased vocabulary, and improved pronunciation. Teachers also made

significant pedagogical adaptations by combining technology and play-based learning and acting as facilitators who guided children's interactions with AI. However, there were a number of obstacles, such as device limitations, internet stability, teachers' digital competence, and concerns about screen time duration.

Based on these findings, this study answers all of the research questions. First, the utilization of AI in ECE takes place through a combination of structured digital and play activities with an introduction, interaction, and AI feedback flow. Second, the teachers' experiences show that AI is a pedagogical tool that enriches teaching but still requires teacher assistance. Third, the children's responses are very positive, as seen in their increased engagement, motivation to learn, and language skills. Fourth, obstacles arise mainly in technical aspects and human resource readiness, requiring efforts to strengthen teacher competence and infrastructure support.

This research has several limitations, including the fact that the research location was limited to one or two early childhood education institutions, so that contextual variations were not fully represented. In addition, the study did not measure language development quantitatively, so improvements in vocabulary and pronunciation were only supported by qualitative observations. The relatively short duration of the study also limited the exploration of the long-term impact of AI use on children's language development.

For further research, it is recommended to expand the scope of the location to include more variations of schools and social contexts. Combined or mixed methods research can be conducted to obtain more measurable quantitative data on language development. In addition, longitudinal studies are needed to examine the long-term impact of AI use on the cognitive, social, and emotional development of early childhood. Future research can also focus on developing AI implementation models that are safe, effective, and in line with the developmental principles of children aged 4–6 years, so that the results can be used as a reference for future education policies.

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