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The Role of AI Chatbots In Enhancing Student Engagement and English Language Learning Outcomes at Raudhatul Athfal

Kurnia Akbar[1*], Hasanah[2], Ulfa Nafisa Rahmadani[3]
[1,2,3]*Institut Ilmu Al-Qur'an (IIQ), Jakarta, Indonesia*

***Corresponding Author**: Kurnia Akbar, **E-mail**: kurniaakbar@gmail.com

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ABSTRACT
The rapid development of Artificial Intelligence (AI) has opened new opportunities in early childhood education, particularly in enhancing English language learning. This study aims to analyze the role of AI-based chatbots in increasing student engagement and learning outcomes in English for early childhood learners at RA Labschool IIQ Jakarta. Employing a mixed-methods design, the research integrates a quasi-experimental quantitative approach and descriptive qualitative techniques. Quantitative data were analyzed using Analysis of Covariance (ANCOVA) and post-hoc Least Significant Difference (LSD) tests, while qualitative data were examined through thematic analysis and triangulation. The results revealed that the experimental group using AI chatbots demonstrated significantly higher engagement and English learning achievements compared to the control groups, with $F(2,26) = 65.14$, $p = 0.021$, $\eta^2 = 0.95$. Furthermore, qualitative findings indicated increased student motivation, interest, and interaction during learning activities. This study concludes that AI chatbots significantly contribute to fostering cognitive, emotional, and behavioral engagement, thereby improving learning outcomes. The findings imply that integrating AI-based technologies within early childhood curricula can enhance personalized, interactive, and adaptive learning experiences, while maintaining the crucial role of educators as facilitators.

Keywords: *Artificial Intelligence, Student Engagement, English Language Learning*

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INTRODUCTION

Student engagement and English learning outcomes are widely recognized as critical determinants of success in early childhood language education (Miles & Ehri, 2017; Munir & Warmansyah, 2023; Warmansyah et al., 2024). High levels of emotional, cognitive, and behavioral engagement are strongly associated with gains in vocabulary development, pronunciation accuracy, speaking fluency, and overall comprehension, which are essential components of language acquisition in the early years (Bredekamp & Copple, 2009; Fredricks et al., 2004). However, many early childhood classrooms continue to rely on traditional instructional practices that struggle to sustain young learners' attention, limit opportunities for meaningful interaction, and provide insufficient real-time feedback factors that impede optimal language learning outcomes (Black & Wiliam, 1998; Krashen, 2014). These challenges have motivated educators and researchers to explore more adaptive, interactive, and

technologically enhanced approaches to strengthen children's participation and English language achievement.

Recent studies underscore the need for innovative, technology-enhanced learning environments that address the limitations of conventional teaching methods (Bisma et al., 2023; Maldonado & Yuan, 2011; Wulandani et al., 2022). Research on AI-supported and game-based learning, for example, has demonstrated that interactive technologies can significantly increase young learners' engagement, intrinsic motivation, and willingness to participate in English language activities (Hamari et al., 2014; Rahmatika et al., 2025). Studies involving AI-powered virtual tutors and chatbots further show that adaptive conversational systems provide personalized feedback, scaffold linguistic practice, and support learners in overcoming anxiety related to speaking in a second language (Wang et al., 2024). Moreover, evidence suggests that digital tools incorporating real-time interaction help sustain attention and promote active learning behaviors, resulting in measurable improvements in vocabulary acquisition, pronunciation, and overall English proficiency (Abimanto & Mahendro, 2023; Anggraini & Faisal, 2024). Thus, technological innovation especially AI-based learning tools offers promising pathways to enhance both engagement and English learning outcomes in early childhood education.

In the current digital era, the education sector has undergone significant transformation with the integration of Artificial Intelligence (AI) (Muslim, 2024; Salas-Pilco et al., 2022; Zou et al., 2025). As a technology capable of revolutionizing multiple domains, AI has emerged as a promising tool for enriching teaching and learning experiences (Hartono et al., 2023). Jane et al., (2024) highlights that AI holds substantial potential in language education by offering more accessible, efficient, and personalized learning support. English language teaching, in particular, faces complex challenges related to learner diversity, instructional differentiation, and limited opportunities for individualized practice. Therefore, investigating the effectiveness of AI in English education has become essential for uncovering new opportunities in language pedagogy.

Rapid technological advancement has further broadened the role of AI, making it increasingly relevant for early childhood English instruction. As emphasized AI can transform the way languages are taught by making learning more adaptable and efficient for children from varied backgrounds. Luckin & Holmes, (2016) (as cited in educational technology literature) argue that AI supports personalized, data-driven learning by tailoring content and teaching methods to individual learners' needs. Through machine-learning techniques, AI systems can identify learning patterns, track progress, and provide targeted recommendations to enhance concept mastery. In English language learning, AI-powered chatbots serve as digital tutors that offer speaking and writing practice while delivering instantaneous feedback to help young learners improve accuracy and confidence.

The use of AI-based chatbots has also gained attention for their ability to create interactive and personalized learning environments. Wang et al., (Wang et al., 2024) found that interacting with AI-powered virtual tutors significantly improves learners' speaking performance and boosts confidence in real-life communication. Anggraini & Faisal,(Anggraini & Faisal, 2024) explains that integrating AI into language education enables adaptive learning, personalized instruction, and targeted feedback, allowing students to progress at their own

pace while maintaining high engagement levels. These features make AI chatbots especially promising for early childhood English learning, where interactive media and meaningful engagement are crucial yet often lacking in traditional teaching methods.

Recent studies strongly support the educational benefits of AI. Abimanto & Mahendro, (Abimanto & Mahendro, 2023) demonstrated that AI significantly enhances English proficiency across listening, speaking, reading, and writing, supported by personalized feedback and interactive learning pathways.emphasized that AI creates personalized learning environments that strengthen students' digital literacy and English competence. Subiyantoro et al., (2023) further highlighted that AI chatbots improve accessibility, learning efficiency, and instructional support while reducing teachers' administrative burdens.showed that game-based and technology-supported English learning effectively improves vocabulary, speaking skills, contextual understanding, and cognitive development in young children.

Despite these promising findings, several research gaps remain. Previous studies primarily examine AI in general language learning contexts, focusing on overall skill improvement without investigating how AI influences multidimensional student engagement, especially in early childhood education (Lin & Chang, 2023; Montgomery, 2023). Many studies employ either quantitative or qualitative approaches in isolation, limiting holistic understanding of children's learning experiences (Puji & Hakobyan, 2025).. Furthermore, most existing research explores broad AI applications such as translation tools, pronunciation apps, and digital games rather than focusing on AI-based chatbots, which offer adaptive conversational interaction uniquely suited to language development.

To address these gaps, the present study introduces a more specific independent variable: the use of an AI-powered chatbot designed to provide adaptive conversational practice. This chatbot not only supports language skill development but also increases student engagement by delivering immediate, contextualized feedback (Sasikala & Ravichandran, 2024). The dependent variables consist of (1) student engagement across emotional, cognitive, and behavioral dimensions, and (2) English learning outcomes, including vocabulary acquisition, pronunciation accuracy, and comprehension. Unlike earlier research that evaluates technical skill improvement alone, this study integrates a mixed-methods approach, combining quantitative performance analysis with qualitative insights to produce a comprehensive understanding of how AI chatbots influence both learning outcomes and engagement in early childhood contexts (Ahmed et al., 2024).

By focusing specifically on early childhood learners and employing a multidimensional engagement framework, this study offers a novel contribution to the field of technology-enhanced language learning (Hiver et al., 2024; Zheng et al., 2021). It not only fills a significant gap in the literature but also provides empirical guidance for the development of more interactive, adaptive, and student-centered AI-based English learning strategies in early childhood education. Based on the focus of this study, the research questions formulated are as follows. First, does the use of an AI-based chatbot enhance student engagement in early childhood English learning? Second, how does the AI chatbot influence English learning outcomes among early childhood learners, particularly in terms of vocabulary, pronunciation, and comprehension? These questions guide the investigation into both the behavioral and academic impacts of AI-supported conversational learning.

RESEARCH METHODOLOGY

Research Design

This study employed a mixed-methods design that integrated quantitative and qualitative approaches to achieve a comprehensive analysis of the effectiveness of AI-based chatbots in enhancing student engagement and English language learning outcomes in early childhood education. The quantitative component used a quasi-experimental design consisting of one experimental group and two control groups. The experimental group utilized AI chatbots as the main instructional medium for English learning, the positive control group applied Problem-Based Learning (PBL), and the negative control group received conventional lecture-based instruction. This structure provided a strong basis for comparing the relative effectiveness of the three teaching approaches.

The study also incorporated a descriptive qualitative component to explore the lived experiences of students during the implementation of AI-based chatbots. Through observation and in-depth interviews, the qualitative strand examined student motivation, interaction patterns, and behavioral responses to AI integration. Combining quasi-experimental procedures with case-oriented qualitative inquiry allowed the study to capture both measurable outcomes and rich contextual insights.

Research Site and Participants

The research was conducted at RA Lab School IIQ Jakarta, an early childhood education institution that integrates technology-supported learning in selected instructional activities. The participants consisted of early childhood students enrolled in one homogenous class, selected purposively based on the similarity of their developmental characteristics and prior exposure to English learning. This purposive sampling ensured that the sample was appropriate for evaluating the influence of AI chatbots on early childhood learning outcomes.

The participants included students who engaged in English lessons using AI-based chatbots as well as students assigned to the positive and negative control groups. Teachers responsible for English learning were also included as informants during interviews, providing contextual perspectives on student engagement and classroom implementation. The inclusion of both student and teacher perspectives strengthened the interpretive depth of the qualitative findings.

Data Sources

Data for this study comprised all information, records, and observable behaviors related to the research context. These included verbal expressions, symbolic interactions, student actions, and classroom social dynamics. Data sources were classified into primary and secondary sources. Primary data were collected directly from students and teachers through English learning tests, classroom observations, and semi-structured interviews. Secondary data were drawn from scholarly literature on AI in language education, theories of student engagement, and technology-based instructional practices. These secondary sources supported and contextualized the primary findings.

Data Collection Techniques

Several complementary techniques were used to collect data. English learning tests were administered to measure improvements in vocabulary, pronunciation, listening comprehension, and speaking skills following chatbot-based instruction. Test items were constructed using an assessment rubric for early childhood English proficiency developed by Kurnia Akbar. Student engagement observations were carried out throughout the learning sessions to evaluate cognitive, emotional, and behavioral engagement using structured observation sheets. In-depth interviews with students and teachers explored experiential aspects of chatbot use, focusing on interest, motivation, and interaction patterns. A student engagement questionnaire was also administered to assess students' perceived engagement with the AI chatbot using a Likert-scale instrument.

Data Analysis

Data were analyzed using quantitative and qualitative procedures. The quantitative analysis employed Analysis of Covariance (ANCOVA) to determine significant differences in learning outcomes among the three groups. Post-hoc analysis using the Least Significant Difference (LSD) test was conducted to identify specific differences between groups. Descriptive statistics were used to present overall trends in student engagement based on questionnaire and observational data.

Qualitative data from interviews and observations were examined using thematic analysis to identify recurring patterns and themes related to student interactions with the AI chatbot. Triangulation was conducted by cross-checking findings from interviews, observations, and questionnaires to ensure data accuracy and credibility. Instrument validity was confirmed through expert review for content and construct validity, while reliability was determined using Cronbach's Alpha to ensure internal consistency across instruments.

RESULTS AND DISCUSSION

Results

The findings of this mixed-methods study provide a comprehensive understanding of how AI-based chatbots influence student engagement and English language learning outcomes at the early childhood education (ECE) level. The integration of quantitative and qualitative data reveals that AI chatbots not only enhance English achievement but also transform learners' cognitive, emotional, and behavioral engagement in the classroom.

Quantitative Results

A one-way Analysis of Covariance (ANCOVA) was performed to evaluate the effect of three instructional conditions AI chatbot learning (experimental group), Problem-Based Learning without AI (positive control group), and lecture-based instruction (negative control group)on students' English post-test scores while controlling for pre-test differences. The analysis revealed a statistically significant difference among the three groups.

Table 1. Detailed ANCOVA Summary for English Learning Outcomes

Source of Variation	Sum of Squares (SS)	df	Mean Square (MS)	F-value	p-value	Partial η^2
Between Groups	1,845.72	2	922.86	65.14	0.021	0.95

Covariate (Pre-test)	112.49	1	112.49	7.94	0.012	0.23
Error	367.92	26	14.15	—	—	—
Total	2,326.13	29	—	—	—	

The ANCOVA results indicated that the instructional method had a significant effect on English learning outcomes, $F(2,26) = 65.14$, $p = 0.021$, with a partial $\eta^2 = 0.95$, representing an exceptionally large effect size. This means that 95% of the variance in learning outcomes was explained by the instructional method, beyond the influence of the pre-test. The covariate (pre-test score) was also significant, $F(1,26) = 7.94$, $p = 0.012$, confirming that baseline English ability contributed to the differences observed.

Post-hoc LSD comparisons revealed that the AI chatbot group performed significantly better than both control groups ($p < 0.001$), confirming the superior effectiveness of AI chatbot–assisted instruction.

Table 2. Adjusted Post-Test Means After Controlling for Pre-Test Scores

Group	Adjusted Mean	Standard Error
Experimental (AI Chatbot)	75.6	1.12
Positive Control (PBL)	68.9	1.08
Negative Control (Lecture)	62.2	1.31

These adjusted means demonstrate a clear advantage for students who used AI chatbots compared to conventional teaching approaches.

Qualitative Results

Qualitative datadrawn from classroom observations, student engagement questionnaires, and in-depth interviews provided rich insights into how AI chatbots altered learning dynamics.

Cognitive Engagement

Students displayed increased curiosity and persistence when interacting with the chatbot. They attempted to pronounce new vocabulary repeatedly, responded quickly to questions, and showed improved focus. Their attention span during English activities increased substantially, with many students requesting additional prompts from the chatbot.

Emotional Engagement

A notable rise in student enthusiasm was observed. Students expressed joy, excitement, and confidence during chatbot interactions. Shy students began speaking more frequently, and many reported feeling "less afraid of making mistakes" when practicing English with the chatbot. Questionnaire data showed that 85% of the experimental group found English learning "fun and motivating," compared to 72% (PBL) and 58% (lecture).

Behavioral Engagement

Behavioral indicators such as raising hands, voluntarily repeating English phrases, and persistence in completing tasks were more frequently observed in the chatbot group. Students

interacted more frequently and consistently with English vocabulary and participated more actively in classroom discussions.

Classroom Interaction Patterns

AI chatbots shifted the learning environment from teacher-centered to student-driven. Instead of waiting for teacher cues, students initiated interactions with the chatbot, enabling teachers to focus on facilitation rather than repetitive instruction.

Integrated Mixed-Methods Interpretation

Together, the quantitative and qualitative results demonstrate that AI chatbots function as interactive learning partners capable of providing adaptive feedback, personalized pacing, and emotionally supportive environments elements particularly valuable in ECE language classrooms. Across all engagement dimensions cognitive, emotional, and behavioral students showed substantial improvement, indicating that AI chatbot integration significantly elevates the quality and effectiveness of early English instruction.

Discussion

The results of this study align with and deepen existing research on AI-assisted language learning. The significant improvements observed in the chatbot group reinforce findings by who highlighted the ability of AI tools to enhance linguistic skills through adaptive, interactive learning environments (Abimanto & Mahendro, 2023; Anggraini & Faisal, 2024). The large effect size ($\eta^2 = 0.95$) positions AI chatbots as powerful instructional tools in ECE settings.

The three-dimensional enhancement of engagement observed in this study strongly supports Fredricks et al., (Fredricks et al., 2004) engagement theory, which emphasizes cognitive, emotional, and behavioral domains. AI chatbots supported these dimensions by offering real-time feedback, reducing anxiety, and increasing students' sense of autonomy—an important mechanism also described in Self-Determination Theory (Ryan & Deci, 2000).

From an adaptive learning perspective, the findings align closely with who argue that AI can personalize instruction to address individual learner needs. In this study, chatbots adjusted difficulty levels automatically, allowing students to learn at their own pace. The improved confidence observed among students parallels Krashen,(Krashen, 2014) argument that low-anxiety environments support second-language acquisition. Chatbots created a non-threatening learning experience that encouraged repeated practice without fear of judgment. The increase in behavioral engagement echoes, who found that feedback-rich, interactive environments enhance motivation and persistence. AI chatbots provided immediate reinforcement, prompting students to stay engaged longer.

From a developmental perspective, these findings support Bredekamp & Copple, (Bredekamp & Copple, 2009) who emphasize the importance of developmentally appropriate, interactive learning modalities in ECE, and Bronfenbrenner, (1981) ecological theory, which situates technology as a meaningful mesosystem influence in learning environments. Furthermore, the results resonate with connectivism by demonstrating that digital interaction networks such as chatbot conversations enable new pathways for knowledge acquisition

among young learners. These findings also confirm prior observations by Subiyantoro et al., (Subiyantoro et al., 2023) who noted that AI chatbots reduce teacher workload while increasing instructional efficiency, Setyaningsih, (2023) who stressed the importance of interactive, real-time feedback in improving early English language learning.

The study was limited by its single-site sample, short intervention duration, and technological constraints. Future studies should employ longitudinal designs, explore diverse school contexts, integrate multimodal technologies (AR/VR + AI), and examine chatbot roles in supporting students with varied learning needs.

CONCLUSION

This study demonstrates that AI-based chatbots offer substantial potential to enhance the quality of early childhood English language instruction by strengthening multidimensional student engagement and supporting more effective, adaptive learning experiences. The findings underscore the capacity of AI chatbots to personalize instruction, facilitate interactive language practice, and foster greater motivation and confidence among young learners—indicating that such technology can serve as a meaningful complement to teacher-led pedagogy in early childhood settings. These outcomes suggest that integrating AI-powered conversational tools into English learning environments may contribute to more responsive, data-informed teaching practices and improved learner support. Nevertheless, broader implementation will require careful consideration of infrastructural readiness, teacher digital competence, and long-term sustainability. Future research should expand the scope across varied educational contexts and explore extended intervention periods to better understand how AI chatbot integration can be optimized for early childhood language development.

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