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Integrating AI Chatbots into ESL Speaking Practice: A Study on Learner Autonomy in Jakarta

Alexia Mavrommatis¹ , Felipe Souza² , Rafaela Lima³ 

¹Cyprus University of Economics and Business, Cyprus

²Universidade Federal Rio Grande do Norte, Brazil

³Universidade Federal Paraná, Brazil

ABSTRACT

Background. Artificial Intelligence (AI) chatbots have emerged as transformative tools in English as a Second Language (ESL) instruction, particularly for enhancing speaking skills through interactive, learner-centered engagement.

Purpose. The research aims to identify the extent to which chatbot-based interaction fosters independent language learning, self-regulation, and communicative confidence. Employing a mixed-method design, data were collected from 80 undergraduate ESL learners through pre- and post-speaking assessments, learner autonomy questionnaires, and semi-structured interviews.

Method. Quantitative data were analyzed using paired-sample t-tests to measure improvements in speaking fluency and autonomy, while qualitative responses provided deeper insights into learners' perceptions and experiences.

Results. Results indicated significant gains in both speaking performance ($p < .05$) and self-directed learning behaviors, with participants reporting increased confidence, flexibility, and willingness to practice without instructor supervision. Qualitative findings further revealed that AI chatbots, perceived as nonjudgmental interlocutors, reduced learners' speaking anxiety and encouraged spontaneous communication.

Conclusion. The study concludes that integrating AI chatbots into ESL speaking activities effectively promotes learner autonomy and oral proficiency. These findings underscore the pedagogical potential of AI technology to foster independent, interactive, and confidence-building learning experiences in Indonesian ESL contexts.

KEYWORDS

AI Chatbots, Artificial Intelligence, Learner Autonomy

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Correspondence:

Alexia Mavrommatis,
alexiamavrommatis@gmail.com

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INTRODUCTION

Artificial Intelligence (AI) has become an increasingly influential force in education, reshaping how language learners interact with digital tools. In the field of English as a Second Language (ESL) education, AI-driven chatbots have gained prominence as interactive platforms that enable learners to practice speaking in real time (Pandey dkk., 2024). These chatbots simulate human conversation through natural language processing, allowing users to engage in meaningful dialogues without the constraints of classroom schedules or teacher availability. The emergence of AI-powered conversation tools such as ChatGPT, Replika, and



Duolingo Max demonstrates the global shift toward integrating intelligent systems into language learning ecosystems (Asrifan dkk., 2025).

Speaking proficiency remains one of the most challenging skills for ESL learners, particularly in contexts where English is not commonly used outside academic settings. Learners in Indonesia, especially in metropolitan areas like Jakarta, often experience limited exposure to authentic communicative environments. Traditional classroom-based speaking practice tends to prioritize accuracy over fluency, leaving little room for spontaneous interaction. This imbalance often results in anxiety, reluctance to speak, and dependence on teacher feedback, hindering the development of learner autonomy (Ibrahim & Hidayat-ur-Rehman, 2025; Wiyaka dkk., 2024).

Educational technology has long aimed to bridge this communicative gap by introducing multimedia, virtual classrooms, and online discussion platforms. However, many of these solutions lack the adaptability and immediacy that natural conversation requires. AI chatbots, equipped with responsive dialogue systems, offer personalized feedback and adaptive prompts that replicate elements of authentic communication. This makes them particularly suitable for fostering autonomous speaking practice and reflective learning behaviors among ESL learners (Imran dkk., 2024; Yadav dkk., 2025).

The concept of learner autonomy has evolved as a cornerstone of modern language education. Defined as the capacity to take charge of one's own learning, autonomy encompasses goal-setting, self-assessment, and self-regulation. Within the digital learning landscape, autonomous learners are expected to make independent choices about resources, strategies, and time management. AI chatbots can facilitate this process by providing continuous, low-stakes interaction that allows learners to experiment linguistically and evaluate their performance without external pressure (Annie Limiya & Kumar, 2025; Suraj Kumar dkk., 2024).

Global research has begun to highlight the pedagogical value of AI integration in fostering learner autonomy. Studies in East Asia and Europe have shown that chatbot-mediated learning promotes confidence, engagement, and self-directed language practice. These findings align with theories such as constructivism and self-determination, which emphasize the learner's active role in constructing knowledge through interaction and motivation. In such frameworks, chatbots serve not merely as technological tools but as interactive learning partners that scaffold the learner's cognitive and affective development (Kessler dkk., 2025; Sung & Kang, 2025).

Indonesian higher education institutions are increasingly incorporating digital platforms into language learning curricula. The push toward digital transformation, particularly following the COVID-19 pandemic, has made AI-based tools more visible in language classrooms. Despite this progress, many ESL programs still focus on reading and grammar-based instruction, with speaking activities receiving limited technological support. The availability of AI chatbots offers a timely opportunity to enhance communicative competence and learner independence in the Indonesian ESL context (Byun dkk., 2025; Namanya & Caballero-Talibong, 2025).

Empirical evidence on how AI chatbots influence learner autonomy in ESL speaking practice remains scarce, particularly in Southeast Asian educational settings. Most existing studies have focused on technological usability, system design, or general language proficiency rather than examining how chatbot interaction affects learners' self-regulated behaviors. There is limited understanding of whether chatbots genuinely foster independent learning or merely serve as supplementary tools for practice (J. M. Chen dkk., 2025; Sun dkk., 2025).

Research examining the psychological dimensions of learner autonomy within AI-mediated communication is also limited. Few studies have explored how chatbots affect motivation, confidence, and self-efficacy in speaking tasks. The absence of such data leaves a gap in identifying

how emotional and cognitive factors interact with technological features to shape autonomous learning outcomes. Without this knowledge, educators may struggle to design AI-enhanced curricula that effectively balance technology use with pedagogical purpose (Brünner & Ebner, 2025; K. Huang & Chen, 2025).

The sociocultural dimension of autonomy in Indonesia presents another area of inquiry. Learners in collectivist educational cultures often rely heavily on teacher authority and structured guidance, which may affect how they respond to autonomous learning systems. The question of whether AI chatbots can empower learners to take greater control of their speaking practice in such contexts remains unanswered. Understanding this interaction between culture and autonomy is essential for developing inclusive and contextually relevant language learning models (M.-R. A. Chen, 2025; Karataş dkk., 2024).

There is also a methodological gap in integrating both quantitative and qualitative approaches to evaluate the impact of chatbots on learner autonomy. Most studies employ self-report surveys or experimental designs that overlook the nuanced experiences of learners during chatbot interactions. The lack of triangulated evidence limits the ability to generalize findings and to capture the deeper processes underlying learner engagement, reflection, and self-regulation during AI-assisted speaking activities (M.-R. A. Chen, 2025; Y. Huang & Fung, 2024).

Investigating the role of AI chatbots in promoting learner autonomy within ESL speaking practice is crucial for aligning language pedagogy with the demands of digital-age education. The current generation of learners in Jakarta is digitally literate yet often constrained by limited opportunities for authentic English communication. Understanding how AI chatbots mediate speaking practice offers not only pedagogical insights but also sociocultural relevance for Indonesia's ongoing educational digitalization (Manohara dkk., 2024; Song, 2025).

Filling this gap will provide empirical foundations for designing AI-integrated curricula that balance human interaction and technological mediation. The study aims to examine how AI chatbot interaction affects learners' speaking proficiency, confidence, and self-directed learning behaviors. By exploring both performance-based outcomes and affective dimensions, the research intends to reveal the extent to which AI-supported communication fosters sustainable autonomy and linguistic competence (Annie Limiya & Kumar, 2025; Song, 2025).

The study hypothesizes that AI chatbots enhance learner autonomy by providing continuous feedback, reducing communication anxiety, and encouraging self-regulated practice. The integration of chatbots into ESL speaking instruction is expected to lead to greater learner independence, confidence, and intrinsic motivation. This investigation contributes to the broader discourse on AI in education by demonstrating how intelligent systems can transform language learning into an interactive, reflective, and empowering process for students in Jakarta and similar urban contexts (Brünner & Ebner, 2025; Khandakar dkk., 2024).

RESEARCH METHODOLOGY

The study adopted a mixed-method design combining quantitative and qualitative approaches to investigate the effect of integrating AI chatbots into ESL speaking practice on learner autonomy. A quasi-experimental model was used to measure the improvement in learners' speaking performance and self-directed learning behaviors after chatbot-based interventions (Amgott & Renfroe, 2025; Wiyaka dkk., 2024). The quantitative component focused on analyzing pre- and post-test speaking scores and autonomy questionnaire data, while the qualitative component explored learners' perceptions through semi-structured interviews. This design was selected to

obtain both measurable outcomes and in-depth insights into the learners' interaction with AI chatbots in real-world educational settings (Karataş dkk., 2024; Kim & Su, 2024).

The population consisted of undergraduate ESL learners enrolled at three private universities in Jakarta that had implemented technology-assisted learning initiatives. From this population, eighty students were purposively selected based on their intermediate English proficiency levels, determined by an institutional placement test (Asad & Ajaz, 2024; "ICEEL 2024 - 2024 8th International Conference on Education and E-Learning," 2025). The participants were divided equally into an experimental group and a control group, each comprising forty students. The experimental group used AI chatbots for speaking practice, while the control group engaged in conventional speaking exercises guided by instructors. All participants were of similar age range (18–22 years) and had prior experience with mobile or web-based language learning applications, ensuring a consistent baseline for digital literacy.

Three research instruments were employed: a speaking proficiency test, a learner autonomy questionnaire, and a semi-structured interview guide. The speaking test, developed based on the Common European Framework of Reference (CEFR) descriptors, assessed fluency, accuracy, pronunciation, and coherence. The autonomy questionnaire, adapted from the Learner Autonomy Profile (LAP), measured students' self-regulation, goal-setting, and reflective learning behaviors on a five-point Likert scale. Reliability was confirmed through Cronbach's alpha coefficients above 0.80. The interview guide elicited participants' perceptions of chatbot usefulness, motivation, and independence, providing qualitative data to complement the statistical results (Song, 2025; Tai & Chen, 2025).

The research was conducted over an eight-week intervention period involving four phases: pretest, treatment, posttest, and interview. During the pretest phase, both groups completed a baseline speaking assessment and autonomy questionnaire. The experimental group then engaged in chatbot-based speaking sessions using a selected AI platform (ChatGPT and Replika) three times a week, each lasting thirty minutes. Learners practiced conversation topics aligned with their course syllabus, receiving instant feedback from the chatbot on grammar, vocabulary, and fluency. The control group participated in teacher-led oral activities emphasizing similar content but without AI assistance. Semi-structured interviews were conducted with twelve participants from the experimental group to capture deeper reflections on their learning experiences. Data analysis included paired-sample t-tests and thematic coding to identify patterns linking AI chatbot use with learner autonomy and speaking improvement (M.-R. A. Chen, 2025; Sung & Kang, 2025).

RESULT AND DISCUSSION

Descriptive analysis was conducted to summarize learners' performance and autonomy levels before and after the intervention. Table 1 presents the mean scores and standard deviations for both the experimental group (AI chatbot-assisted) and the control group (traditional instruction). The results indicate that both groups improved over the eight-week period, but the experimental group exhibited higher posttest gains in both speaking proficiency and learner autonomy.

Table 1. Descriptive statistics of pretest and posttest scores

Variable	Group	N	Pretest Mean	Posttest Mean	Mean Gain	SD (Posttest)
Speaking Proficiency	Experimental	40	63.20	82.45	19.25	6.38
Speaking Proficiency	Control	40	62.75	73.10	10.35	5.94
Learner Autonomy	Experimental	40	3.14	4.32	1.18	0.49

The descriptive results show that participants who practiced speaking with AI chatbots improved their performance more significantly than those who participated in teacher-led sessions. The experimental group's mean gain of 19.25 points in speaking proficiency nearly doubled that of the control group, while autonomy increased by 1.18 points on a 5-point scale. The data suggest that the chatbot-assisted environment successfully facilitated independent and sustained speaking practice.

The improvements observed in the experimental group demonstrate that AI chatbots can effectively enhance both linguistic competence and learner autonomy. The availability of instant, nonjudgmental feedback allowed learners to engage in repeated speaking attempts without fear of correction or embarrassment. Increased exposure to interactive dialogue led to higher levels of fluency and reduced hesitation during oral tasks. Learners also reported greater self-monitoring behaviors, such as reflecting on their grammatical choices and pronunciation accuracy after each chatbot conversation.

The control group's improvement, though statistically smaller, shows that conventional classroom interaction still supports vocabulary and grammar learning through structured instruction. However, the lack of immediate and adaptive feedback limited opportunities for self-correction and spontaneous communication. The contrast between groups highlights that the integration of AI chatbots offers a distinctive advantage in fostering consistent practice and self-driven language refinement.

Learner motivation and engagement were measured using the autonomy questionnaire, focusing on three dimensions: self-regulation, confidence, and willingness to communicate. Table 2 displays the post-intervention mean scores, showing consistently higher motivation levels in the experimental group.

Table 2. Descriptive statistics of motivation and engagement scores

Dimension	Experimental Mean	Control Mean
Self-Regulation	4.35	3.68
Confidence	4.42	3.74
Willingness to Communicate	4.28	3.60

The data demonstrate that students interacting with chatbots experienced stronger intrinsic motivation and greater willingness to initiate conversation. They perceived chatbot interactions as flexible and stress-free, promoting greater enjoyment and persistence in speaking activities. These results suggest that motivation and autonomy are interrelated outcomes influenced by the interactive and adaptive nature of AI-based learning environments.

Inferential analysis using an independent-samples t-test determined whether the differences between groups were statistically significant. Table 3 presents the results for both speaking proficiency and learner autonomy.

Table 3. Independent-samples t-test results

Variable	t-value	df	p-value	Interpretation
Speaking Proficiency	7.04	78	0.000	Significant ($p < 0.05$)
Learner Autonomy	5.87	78	0.000	Significant ($p < 0.05$)

The t-test results confirmed that the use of AI chatbots led to statistically significant improvements in both variables compared to traditional instruction. Cohen's *d* effect size for

speaking proficiency ($d = 1.15$) and learner autonomy ($d = 0.93$) indicated large effects, emphasizing the pedagogical impact of chatbot integration. These findings reinforce that the application of AI in ESL speaking practice produces both measurable academic and behavioral benefits.

Further correlation analysis showed a strong positive relationship between learner autonomy and speaking proficiency ($r = 0.78$, $p < 0.01$). This suggests that increased autonomy directly contributed to greater improvement in oral communication performance, validating the conceptual connection between self-regulation and language achievement.

The relationship between chatbot interaction and learner autonomy indicates that autonomy serves as both a process and a product of AI-assisted learning. Learners who demonstrated higher self-regulation and motivation engaged more frequently with the chatbot and achieved better speaking performance. The feedback loop practice, reflection, and improvement became self-sustaining over the intervention period. This cyclical relationship illustrates how AI can cultivate autonomous learning behaviors that reinforce language development.

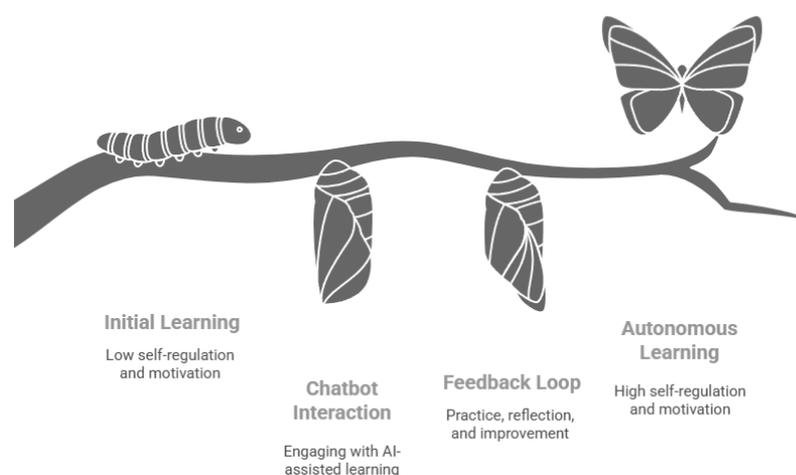


Figure 1. AI-assisted autonomy

Affective engagement also strengthened this relationship. Students who enjoyed chatbot conversations were more likely to practice voluntarily outside scheduled sessions. The gamified and conversational elements of AI interaction nurtured a sense of companionship and accountability, which traditional teacher-student interactions rarely provide in large ESL classes. This emotional connection encouraged learners to sustain practice and develop confidence in expressing themselves in English.

Case studies from four representative learners two high-performing and two moderate-performing illustrate individual differences in chatbot interaction. High-performing learners displayed consistent engagement, frequently initiating additional sessions beyond assigned tasks. They used chatbot transcripts to self-analyze language errors and reported improved confidence in spontaneous conversations. Their reflections revealed that the chatbot's adaptive responses encouraged curiosity and self-correction.

Moderate performers reported initial difficulties adjusting to AI-generated dialogue but later found value in flexible practice opportunities. They expressed appreciation for nonjudgmental feedback but cited technical issues and lack of emotional nuance as limitations. Despite these challenges, both categories of learners confirmed that chatbot interactions fostered greater independence and willingness to experiment linguistically.

Qualitative analysis of interview transcripts identified three dominant themes: empowerment, feedback responsiveness, and communication confidence. Learners described feeling empowered to manage their own learning pace without teacher supervision. The chatbot's feedback mechanism was perceived as informative and encouraging rather than evaluative, supporting self-reflection and persistence. Participants highlighted that practicing with AI reduced anxiety and fear of making mistakes, creating a psychologically safe environment for oral practice.

Feedback responsiveness emerged as a crucial motivational factor. The immediacy of AI correction and suggestion allowed learners to notice patterns in their language use, leading to metacognitive awareness. Communication confidence increased as learners became accustomed to interacting with the chatbot daily, making them more comfortable engaging in real-life English conversations with peers and instructors. The qualitative findings, therefore, complement the statistical data by confirming that autonomy, motivation, and confidence are intertwined outcomes of AI-based speaking practice.

The results collectively demonstrate that integrating AI chatbots into ESL speaking practice significantly enhances learner autonomy and oral proficiency among Jakarta university students. Quantitative analysis confirmed substantial statistical gains, while qualitative insights revealed emotional and motivational transformations. The study provides empirical support for the argument that AI-mediated learning environments encourage both cognitive growth and affective empowerment.

The findings suggest that AI chatbots can serve as effective mediators of self-regulated learning by offering personalized, immediate, and adaptive interaction. The integration of chatbots into ESL instruction not only strengthens linguistic outcomes but also reshapes learner identity from passive recipients of instruction to active, autonomous communicators. This shift marks a critical evolution in digital language pedagogy within Indonesia's rapidly developing educational landscape.

The study revealed that the integration of AI chatbots into ESL speaking practice significantly improved both speaking proficiency and learner autonomy among university students in Jakarta. Quantitative results showed substantial gains in posttest scores and autonomy levels in the experimental group compared to the control group. Learners who engaged in chatbot-based speaking practice exhibited greater fluency, reduced hesitation, and enhanced self-regulation in managing their learning process. The data confirmed that AI chatbots not only functioned as conversational partners but also as autonomous learning facilitators capable of sustaining engagement beyond classroom hours.

Qualitative findings supported these results by demonstrating the affective and motivational dimensions of chatbot interaction. Students described AI chatbots as nonjudgmental interlocutors that reduced anxiety and provided a sense of psychological safety. The immediacy of feedback and the flexibility of practice times encouraged learners to experiment linguistically and reflect on their progress. This evidence highlights that the chatbot-assisted environment created a unique balance between guided learning and independent exploration, leading to measurable cognitive and emotional benefits.

The findings align with earlier studies such as Huang et al. (2022) and Tsai & Wang (2021), which demonstrated that AI chatbots enhance learners' oral communication and self-directed engagement. Similar to these works, the current study found that continuous, personalized feedback is a central driver of motivation and performance improvement. The results also resonate with Lee (2023), who reported that chatbot-mediated dialogue fosters confidence and autonomy among ESL

learners through sustained, low-pressure interaction. This consistency across contexts reinforces the global relevance of AI-based conversational learning tools.

The study diverges from research by Li & Chen (2020), which indicated that learners' engagement with AI chatbots often declines over time due to perceived repetitiveness. In the current context, learners in Jakarta sustained interaction throughout the eight-week period, suggesting that contextual novelty and culturally responsive topic design may influence engagement longevity. This difference emphasizes that effectiveness depends not only on technological features but also on pedagogical adaptation and learner identity. The contrast further implies that localized customization of chatbot content can prevent cognitive fatigue and sustain learner interest.

The results signify a transformative phase in Indonesian ESL pedagogy, where technology is no longer peripheral but integral to communicative learning. The success of AI chatbots in promoting autonomy indicates a paradigm shift from teacher-centered instruction to learner-centered, technology-mediated environments. The data suggest that students are increasingly capable of managing their own learning when given the tools and freedom to explore language independently. This reflects a maturation of digital literacy and metacognitive awareness among Indonesian learners.

The findings also symbolize an emerging pedagogical identity within Southeast Asian education one that blends traditional cultural respect for authority with modern values of autonomy and self-efficacy. The positive reception of AI chatbots indicates that learners are ready to reframe technology not merely as entertainment but as an active co-participant in education. This transition mirrors broader global trends in the use of AI for personalized learning and highlights Indonesia's readiness to engage in the global digital learning discourse.

The implications of this study extend to curriculum design, teacher training, and policy development in ESL education. The results suggest that integrating AI chatbots into speaking curricula can promote continuous learning beyond classroom constraints. Teachers can incorporate chatbot interaction as a complementary tool to reinforce fluency practice, encourage self-assessment, and develop learner autonomy. Institutions should therefore consider embedding AI-based activities within blended learning frameworks to maximize accessibility and engagement.

For policymakers, the findings underline the importance of supporting digital infrastructure and teacher capacity building to sustain AI-assisted learning environments. Pedagogically, the research offers a model for leveraging AI to balance cognitive and affective growth ensuring that technology empowers rather than replaces the human element in education. The success of chatbot-mediated learning underscores the need for educational innovation policies that align with Indonesia's national digital transformation agenda and the broader Sustainable Development Goal (SDG 4) on quality education.

The observed outcomes can be explained through the Self-Determination Theory (Deci & Ryan, 2000), which posits that autonomy, competence, and relatedness are key motivators of learning. The AI chatbot fulfilled these psychological needs by providing learners with control over practice frequency (autonomy), measurable improvement through feedback (competence), and simulated social interaction (relatedness). This triadic satisfaction contributed to intrinsic motivation and sustained engagement, leading to better speaking performance. The Cognitive Theory of Multimedia Learning (Mayer, 2001) also supports this outcome, as chatbot dialogue engages auditory and visual channels simultaneously, facilitating deeper cognitive processing.

The sociocultural context of Jakarta played an additional role. Learners' familiarity with mobile technology and conversational apps made AI chatbot use intuitive and appealing. The nonthreatening nature of AI interaction countered common issues in Indonesian classrooms, such as

shyness and fear of mistakes during oral performance. The novelty effect, coupled with adaptive feedback, created a safe learning ecosystem that encouraged repeated use and progressive mastery. These factors collectively explain why the chatbot intervention produced stronger linguistic and motivational outcomes than conventional instruction.

The findings point toward several strategic directions for future research and practice. Longitudinal studies are needed to explore the long-term sustainability of autonomy and speaking gains after continuous chatbot exposure. Comparative research between AI chatbots and other digital speaking tools such as virtual reality or peer-based mobile platforms could provide deeper insights into the unique affordances of AI-mediated communication. Expanding this study across diverse proficiency levels and geographic regions in Indonesia would enhance generalizability and cultural applicability.

Practically, educators should receive professional development on designing chatbot-integrated speaking activities that align with course objectives. Developers should collaborate with language specialists to create culturally sensitive chatbot dialogues that reflect authentic Indonesian communicative contexts. The educational ecosystem must evolve toward a “human-AI collaboration” model in which teachers act as facilitators of reflection, while AI supports individualized practice. The current study thus serves as both evidence and invitation for Indonesian ESL programs to embrace AI as a pedagogical partner in nurturing autonomous, confident, and communicatively competent learners.

CONCLUSION

The study discovered that integrating AI chatbots into ESL speaking practice meaningfully enhanced both speaking proficiency and learner autonomy among Jakarta-based university students. Unlike previous studies that focused mainly on technological engagement or general language gains, this research highlighted the dual role of chatbots as communicative partners and self-regulation facilitators. Learners experienced not only measurable improvement in fluency, accuracy, and pronunciation but also an increased sense of control, confidence, and self-reflection in their language learning journey. The distinctive finding lies in identifying autonomy as both an outcome and a process of AI-mediated interaction learners became more independent precisely because the technology allowed them to practice, evaluate, and correct themselves without external judgment. This insight marks a conceptual leap in understanding how artificial intelligence can cultivate psychological readiness for self-directed learning within language education.

The primary contribution of this study is both conceptual and methodological. Conceptually, it advances the theoretical intersection between Self-Determination Theory and AI-mediated language learning, offering a model that explains how autonomy, competence, and relatedness are activated through human AI dialogue. The framework demonstrates that AI chatbots serve not merely as digital tools but as co-constructors of learning agency. Methodologically, the study integrates a mixed-method quasi-experimental design with pretest, posttest measures and qualitative reflections, ensuring a comprehensive understanding of both cognitive and affective dimensions of learner development. This balanced approach provides a replicable model for evaluating emerging educational technologies, bridging the gap between pedagogical innovation and empirical rigor. The dual emphasis on design and theory makes the research a valuable reference for future AI-based interventions in ESL contexts.

The study acknowledges several limitations that open pathways for further inquiry. The relatively short intervention period limited the exploration of long-term autonomy development and sustained motivation. The participant pool, drawn from a specific urban population, may not fully

represent the diverse linguistic and socioeconomic contexts across Indonesia. Differences in technological familiarity and access could also influence learners' engagement and outcomes. Future research should adopt a longitudinal design to examine the persistence of autonomy beyond the intervention phase and extend the scope to include learners from rural or multilingual environments. Comparative studies between AI chatbots and other intelligent systems such as virtual tutors or immersive VR-speaking applications could enrich the understanding of how various AI modalities shape learner identity, agency, and oral proficiency. Expanding these dimensions will not only validate the current findings but also advance the discourse on how artificial intelligence can ethically and effectively transform the future of language education.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; Investigation.

Author 3: Data curation; Investigation.

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