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The AI-Powered Dialogue: Evaluating the Impact of Large Language Models on EFL Learners' Pragmatic Competence and Speaking Anxiety

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ABSTRACT

Background. The rapid advancement of artificial intelligence has transformed language learning environments, particularly through the integration of Large Language Models (LLMs) that facilitate interactive and personalized communication practice. Despite their growing adoption in English as a Foreign Language (EFL) education, limited empirical attention has been devoted to understanding their influence on learners' pragmatic competence and speaking anxiety.

Purpose. This study aims to evaluate the impact of AI-powered dialogue systems based on LLMs on EFL learners' ability to use language appropriately in social contexts and their confidence in oral communication.

Method. A quantitative quasi-experimental design was employed involving 120 EFL learners divided into experimental and control groups. Data were collected through pragmatic competence assessments, speaking anxiety scales, classroom observations, and structured interviews.

Results. Findings indicate that students who engaged with AI-powered dialogue systems demonstrated significantly higher gains in pragmatic competence compared to those receiving conventional instruction. Results also reveal a substantial reduction in speaking anxiety, attributed to the non-judgmental, adaptive, and accessible nature of AI-mediated interactions.

Conclusion. The study concludes that LLM-based dialogue platforms provide meaningful opportunities for authentic communication practice while fostering psychological comfort in language learning. Integrating AI-powered dialogue into EFL instruction can therefore enhance communicative effectiveness and support learners' confidence in real-world language use.

KEYWORDS

Artificial Intelligence, EFL Learners, Large Language Models, Pragmatic Competence, Speaking Anxiety

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INTRODUCTION

Artificial intelligence has emerged as one of the most transformative forces in contemporary education, fundamentally reshaping how languages are taught, learned, and assessed (Abdallah dkk., 2025). The rapid development of Large Language Models (LLMs), such as ChatGPT and other generative AI systems, has introduced unprecedented opportunities for language learners to engage in interactive, personalized, and context-sensitive

communication (Abdelfattah dkk., 2026). Unlike traditional computer-assisted language learning tools that often rely on predetermined responses and limited interaction patterns, LLM-powered dialogue systems are capable of generating dynamic, human-like conversations that adapt to learners' linguistic proficiency, communicative goals, and learning needs (Albadry, 2025). These capabilities have attracted considerable attention among educators and researchers seeking innovative approaches to enhance English as a Foreign Language (EFL) instruction. The increasing accessibility of AI-powered conversational tools has enabled learners to practice language skills beyond the classroom, creating new possibilities for authentic communication and learner autonomy (Aljohani, 2026). As educational institutions worldwide continue to integrate digital technologies into language education, understanding the pedagogical implications of LLM-based dialogue systems has become an important research priority.

Pragmatic competence represents a critical dimension of communicative competence that enables language learners to use linguistic forms appropriately according to social, cultural, and situational contexts (Almahasneh dkk., 2026). Effective communication in a foreign language requires more than grammatical accuracy and vocabulary knowledge; it also demands an understanding of how language functions in real-life interactions. Many EFL learners experience difficulties in developing pragmatic competence because classroom instruction frequently emphasizes linguistic accuracy while providing limited opportunities for authentic social interaction (Amiri & Ramezanzadeh, 2026). Consequently, learners may struggle to interpret implied meanings, employ appropriate politeness strategies, perform speech acts effectively, or adapt their language use to different communicative situations. Simultaneously, speaking anxiety remains one of the most persistent challenges affecting EFL learners' oral performance (Arslan, 2025). Fear of making mistakes, concerns about negative evaluation, limited confidence, and inadequate opportunities for practice often hinder learners from participating actively in spoken communication. These challenges highlight the need for innovative instructional approaches capable of simultaneously enhancing pragmatic competence and reducing speaking anxiety. AI-powered dialogue systems have been proposed as a potential solution because they provide a supportive, non-judgmental environment in which learners can engage in repeated communication practice without the social pressures commonly associated with human interaction.

Research examining the educational applications of artificial intelligence in language learning has expanded significantly in recent years (Choi, 2025). Existing studies have reported positive outcomes associated with AI-assisted language instruction, including improvements in vocabulary acquisition, grammatical accuracy, reading comprehension, writing quality, and learner motivation. Recent investigations have also explored the role of chatbots and conversational agents in promoting interactive learning experiences and facilitating autonomous language practice (Choi, 2026). Nevertheless, much of the current literature focuses primarily on linguistic performance and general learning outcomes, while comparatively limited attention has been devoted to the development of pragmatic competence. Furthermore, studies investigating the psychological dimensions of AI-assisted language learning, particularly speaking anxiety, remain relatively scarce (Dai & Chen, 2026). Although preliminary findings suggest that AI-mediated interactions may foster greater learner confidence and willingness to communicate, empirical evidence concerning the extent and nature of these effects remains inconclusive. The emergence of advanced LLMs introduces new possibilities for language education due to their ability to generate contextually appropriate responses, simulate authentic conversational scenarios, and provide immediate feedback (Dong & Han, 2024). Despite these promising characteristics, insufficient research has systematically examined how LLM-powered dialogue systems influence both pragmatic

competence and speaking anxiety among EFL learners (Jindapitak & Tantiwich, 2025). This gap underscores the need for comprehensive empirical investigations that evaluate the pedagogical effectiveness of AI-powered dialogue within foreign language learning contexts.

This study aims to evaluate the impact of Large Language Model-based dialogue systems on EFL learners' pragmatic competence and speaking anxiety (Khan & Habib, 2026). Specifically, the research seeks to determine whether sustained interaction with AI-powered conversational tools contributes to learners' ability to employ language appropriately in diverse communicative situations and whether such interactions reduce anxiety associated with speaking English (Kralova & Kunova, 2026). By examining both cognitive and affective dimensions of language learning, this study intends to provide a more holistic understanding of the educational value of AI-mediated communication (Lei, 2026). The investigation also seeks to explore how learners perceive AI-powered dialogue as a learning resource and whether these perceptions influence their engagement with language practice (Lai, 2025). Findings from this study are expected to contribute to ongoing discussions regarding the integration of artificial intelligence into language education and offer evidence-based recommendations for educators, curriculum designers, and policymakers seeking to maximize the pedagogical benefits of emerging technologies.

The significance of this study lies in its contribution to both theoretical and practical dimensions of language education (B. Li dkk., 2025). From a theoretical perspective, the research extends existing knowledge concerning technology-enhanced language learning by examining the intersection between artificial intelligence, pragmatic competence, and speaking anxiety. The study provides insights into how AI-powered dialogue may support communicative competence development through sustained interaction and contextualized language use (L. Li dkk., 2025). From a practical perspective, the findings have the potential to inform instructional practices by identifying effective strategies for incorporating LLM-based technologies into EFL classrooms. Educational institutions increasingly seek innovative approaches that promote learner-centered instruction, foster communicative confidence, and prepare students for participation in globalized communication environments (Liang, 2025). Understanding the impact of AI-powered dialogue systems can help educators design more effective learning experiences that combine technological innovation with pedagogical effectiveness. As artificial intelligence continues to evolve and become more deeply embedded within educational settings, rigorous empirical research is essential to ensure that these technologies are implemented in ways that genuinely enhance learning outcomes and support learners' communicative development (C. Liu & Liang, 2026). Consequently, this study offers timely and relevant contributions to the growing field of AI-assisted language learning while addressing critical challenges associated with pragmatic competence and speaking anxiety among EFL learners.

RESEARCH METHODOLOGY

This study employed a quantitative approach using a quasi-experimental research design with a pretest-posttest control group format. The design was selected to examine the effectiveness of Large Language Model (LLM)-powered dialogue systems in enhancing EFL learners' pragmatic competence and reducing speaking anxiety. Two groups were involved in the study: an experimental group that participated in AI-mediated dialogue activities and a control group that received conventional speaking instruction (G. L. Liu & Soyoof, 2026). The independent variable was the use of AI-powered dialogue systems, while the dependent variables were pragmatic competence and speaking anxiety. The quasi-experimental design enabled the researchers to

compare learning outcomes between groups while maintaining the natural classroom setting in which the intervention was implemented.

The population consisted of undergraduate students enrolled in English as a Foreign Language (EFL) courses at a public university during the 2025–2026 academic year. A total of 240 students were eligible to participate in the study. Using purposive sampling, 120 students who possessed intermediate English proficiency levels based on institutional placement test results were selected as research participants. The participants were divided equally into an experimental group (n = 60) and a control group (n = 60). Selection criteria included regular attendance, prior experience with digital learning platforms, and willingness to participate throughout the study period. The sample size was considered sufficient to provide adequate statistical power for detecting significant differences between groups.

Data were collected using four research instruments. Pragmatic competence was measured through a Pragmatic Competence Test (PCT) adapted from established assessments of speech acts, politeness strategies, request formulations, refusals, and conversational appropriateness. Speaking anxiety was assessed using an adapted version of the Foreign Language Classroom Anxiety Scale (FLCAS), focusing specifically on oral communication anxiety. Classroom observation sheets were employed to document learners' participation, interaction patterns, and communicative behavior during instructional activities (M. Liu dkk., 2026). Semi-structured interview protocols were also utilized to obtain qualitative insights into learners' perceptions of AI-mediated dialogue experiences. Prior to data collection, all instruments underwent content validation by three experts in applied linguistics and educational technology. Reliability testing indicated satisfactory internal consistency, with Cronbach's alpha coefficients exceeding 0.80 for all scales.

The study was conducted over a twelve-week intervention period. Initial activities involved administering pretests to both groups to determine baseline levels of pragmatic competence and speaking anxiety. Students in the experimental group subsequently engaged in structured interactions with an AI-powered dialogue platform based on Large Language Models (Masjedy & Adel, 2025). These interactions included role-play simulations, contextual conversations, pragmatic task completion, and real-time communicative practice designed to mimic authentic language use. Students in the control group received traditional speaking instruction through classroom discussions, pair work, and teacher-guided communicative activities without AI assistance. Monitoring and classroom observations were conducted regularly throughout the intervention to ensure implementation fidelity. Following the completion of the treatment period, posttests were administered to both groups using the same instruments employed during the pretest phase. Quantitative data were analyzed using descriptive statistics, paired-sample t-tests, independent-sample t-tests, and analysis of covariance (ANCOVA) to examine differences between groups. Qualitative interview data were analyzed thematically to support and enrich the quantitative findings regarding the educational impact of AI-powered dialogue systems on pragmatic competence and speaking anxiety.

RESULT AND DISCUSSION

The findings of this study are organized into two major components: descriptive analysis and inferential analysis. Descriptive analysis was conducted to examine changes in EFL learners' pragmatic competence and speaking anxiety before and after participation in AI-powered dialogue activities. Inferential analysis was subsequently performed to determine whether the observed differences between the experimental and control groups were statistically significant. The results reveal a positive influence of Large Language Model-based dialogue systems on learners'

communicative development and emotional readiness for oral interaction. Table 1 presents the descriptive statistics of pragmatic competence and speaking anxiety scores obtained from both groups during the pretest and posttest phases.

Table 1. Descriptive Statistics of Pragmatic Competence and Speaking Anxiety Among EFL Learners Before and After The Intervention

Variable	Group	Pretest Mean	Posttest Mean	Mean Difference	SD
Pragmatic Competence	Experimental	65.42	84.76	19.34	6.12
Pragmatic Competence	Control	64.89	71.25	6.36	6.85
Speaking Anxiety	Experimental	78.53	54.37	-24.16	7.01
Speaking Anxiety	Control	77.94	71.86	-6.08	7.46

Table 1 presents the descriptive statistics of pragmatic competence and speaking anxiety among EFL learners before and after the intervention. Baseline scores indicate that both groups exhibited relatively similar levels of pragmatic competence and speaking anxiety at the beginning of the study. The experimental group recorded a pretest mean score of 65.42 for pragmatic competence, while the control group achieved 64.89. Speaking anxiety scores were also comparable, with mean values of 78.53 and 77.94 respectively.

Posttest results demonstrate substantial improvements among students who participated in AI-powered dialogue activities. The experimental group achieved a posttest mean of 84.76 in pragmatic competence, representing an increase of 19.34 points. Speaking anxiety scores decreased significantly from 78.53 to 54.37, indicating a reduction of 24.16 points. The control group also showed modest improvements; however, the magnitude of change was considerably lower than that observed in the experimental group.

Performance gains in pragmatic competence were observed across several communicative dimensions, including speech acts, conversational appropriateness, politeness strategies, and contextual language adaptation (McKinley dkk., 2024). Students interacting with the Large Language Model (LLM)-based dialogue system demonstrated greater ability to formulate requests, refusals, apologies, and suggestions in socially appropriate ways. Classroom observations revealed that repeated exposure to simulated conversational scenarios enabled learners to recognize contextual variations in language use and respond more effectively to communicative demands.

Interview data further confirmed these findings. Participants reported that AI-generated conversations provided immediate opportunities to practice language in diverse social situations without the fear of negative judgment (Namaziandost & Çelik, 2025). Many learners indicated that the adaptive responses generated by the system helped them understand how language choices vary according to context, interlocutor status, and communicative purpose. Such experiences contributed to noticeable improvements in pragmatic awareness and communicative confidence.

Table 2. Results of the Independent Sample T-Test Conducted to Compare Posttest Scores Between the Experimental and Control Groups

Variable	t-value	Sig. (p)	Decision
Pragmatic Competence	8.741	0.000	Significant
Speaking Anxiety	-7.956	0.000	Significant

Table 2 presents the results of the independent sample t-test conducted to compare posttest scores between the experimental and control groups. Statistical analysis revealed a significant difference in pragmatic competence scores ($t = 8.741$, $p < 0.001$), indicating that students exposed to AI-powered dialogue performed substantially better than those receiving conventional instruction. These findings suggest that interaction with LLM-based systems positively influenced learners' ability to use language appropriately in various communicative contexts.

Results related to speaking anxiety also demonstrated significant differences between groups ($t = -7.956$, $p < 0.001$). Learners in the experimental group reported considerably lower anxiety levels following the intervention. The reduction in anxiety may be attributed to the supportive and non-evaluative nature of AI-mediated interactions, which allowed students to practice speaking without experiencing social pressure commonly associated with classroom communication.

Experiences of individual learners provided additional evidence regarding the effectiveness of AI-powered dialogue systems. One participant initially displayed high levels of speaking anxiety and frequently avoided classroom discussions (Qin dkk., 2025). Following twelve weeks of AI-assisted interaction, the student became more willing to participate in oral activities and demonstrated improved ability to maintain extended conversations using contextually appropriate expressions. Observation records indicated substantial growth in both confidence and communicative competence.

Another participant reported that the AI dialogue platform functioned as a personal language partner available at any time. Continuous engagement with simulated conversations enabled the learner to practice pragmatic features that were rarely addressed during regular classroom instruction (Sun & Lan, 2025). Interview responses suggested that the flexibility, accessibility, and immediate feedback provided by the LLM system played a crucial role in enhancing both language performance and psychological comfort during communication.

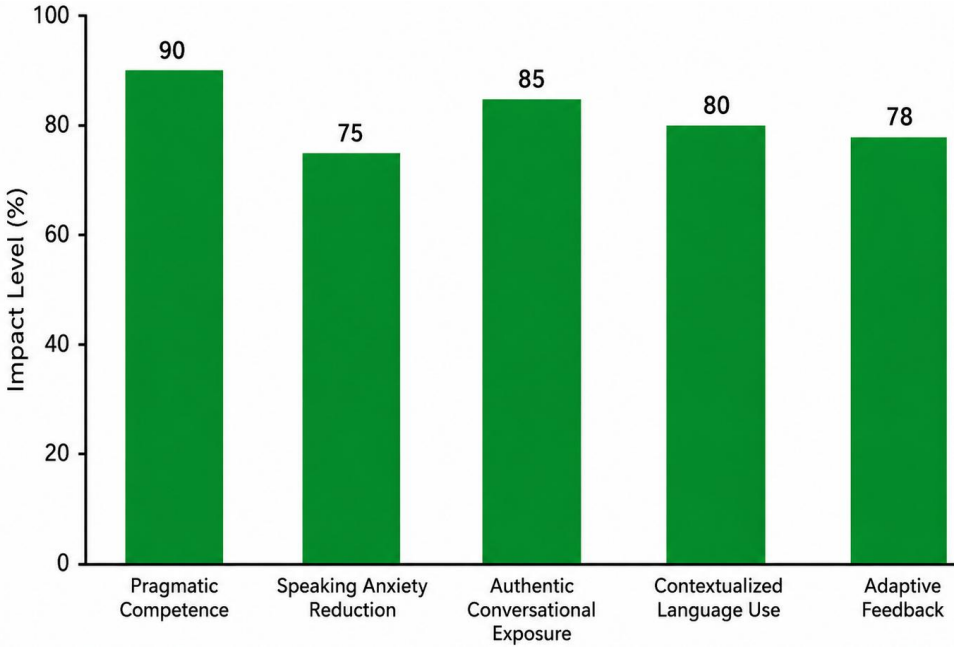

Figure 1. Impact of AI-Powered Dialogue Systems on EFL Learners

Findings indicate that AI-powered dialogue systems based on Large Language Models can significantly improve EFL learners' pragmatic competence while simultaneously reducing speaking anxiety. Improvements appear to result from frequent exposure to authentic conversational exchanges, contextualized language use, and adaptive feedback mechanisms (Tang & Zhang, 2026).

The capacity of LLMs to generate realistic interactions creates meaningful opportunities for learners to practice communication beyond traditional classroom constraints.

Educational implications suggest that integrating AI-powered dialogue into EFL instruction may support both linguistic and affective dimensions of language learning. Enhanced pragmatic competence contributes to more effective communication, whereas reduced speaking anxiety encourages greater participation in oral interaction (Taye, 2026). These outcomes highlight the potential of artificial intelligence as a pedagogical tool capable of fostering communicative competence and learner confidence in contemporary language education.

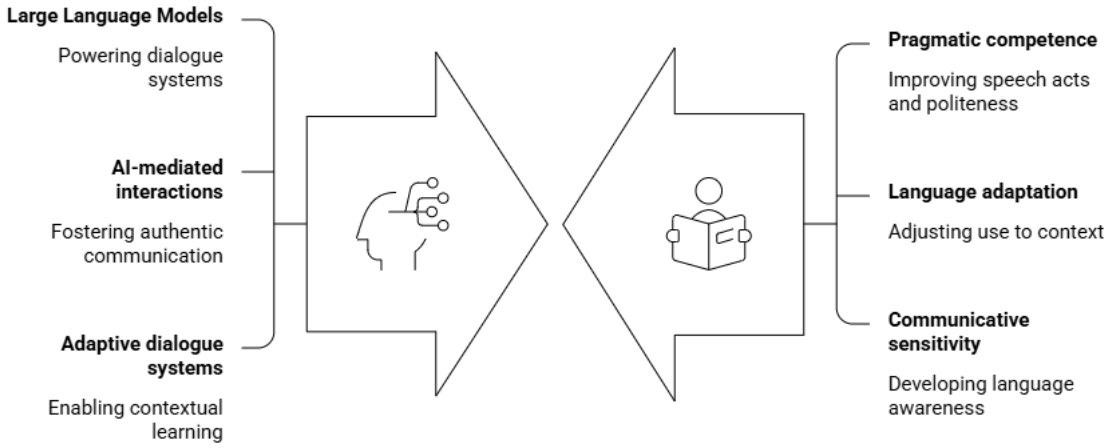

Figure 2. AI Enhances EFL Pragmatic Competence

Findings indicate that AI-powered dialogue systems based on Large Language Models significantly improved EFL learners' pragmatic competence. Students who participated in AI-mediated interactions demonstrated greater ability to perform speech acts, employ appropriate politeness strategies, and adapt language use according to contextual demands. These results align with previous studies highlighting the effectiveness of artificial intelligence in providing authentic communicative experiences and individualized language practice. Research conducted by (C. Wang dkk., 2024) and Kim and (Zhao, 2026) similarly reported that AI-driven conversational platforms facilitate pragmatic development by exposing learners to diverse linguistic scenarios that are often unavailable in traditional classroom environments. Enhanced pragmatic competence observed in this study suggests that frequent interaction with adaptive dialogue systems enables learners to internalize contextual language patterns and develop greater communicative sensitivity.

Results also revealed a substantial reduction in speaking anxiety among learners who engaged with Large Language Model-based dialogue systems. Lower anxiety levels may be attributed to the non-judgmental and supportive nature of AI-mediated communication. Students were able to practice speaking repeatedly without fear of criticism, embarrassment, or negative evaluation from peers and instructors. Similar findings were reported by (Chen, 2026), who found that conversational AI platforms increased learners' willingness to communicate and reduced psychological barriers associated with foreign language speaking tasks. Greater opportunities for self-paced interaction appear to create a psychologically safe learning environment that encourages experimentation and risk-taking during communication. These conditions are particularly beneficial for EFL learners who often experience anxiety when participating in face-to-face oral activities.

Results further suggest that improvements in pragmatic competence and reductions in speaking anxiety are interconnected. Enhanced pragmatic awareness may contribute to greater communicative confidence because learners become more capable of selecting appropriate

linguistic expressions in different social contexts (Zhai & Wibowo, 2023). Reduced anxiety simultaneously allows learners to participate more actively in communicative tasks, thereby creating additional opportunities for pragmatic development. This reciprocal relationship supports sociocultural and communicative competence theories, which emphasize the importance of meaningful interaction in language acquisition. Findings therefore indicate that AI-powered dialogue systems function not only as technological tools but also as facilitators of communicative engagement and psychological empowerment.

Educational implications emerging from this study highlight the potential of integrating Large Language Models into EFL instruction. AI-powered dialogue platforms can complement classroom teaching by providing continuous access to authentic communication practice beyond formal learning settings. Teachers may utilize these technologies to create contextualized speaking activities, individualized learning experiences, and supplementary opportunities for pragmatic development (Wiboolyasarin dkk., 2025). Institutions seeking to promote communicative competence and learner confidence may benefit from incorporating AI-assisted language learning tools into their instructional frameworks. Effective implementation, however, requires pedagogical guidance to ensure that technology supports meaningful interaction rather than replacing human communication.

Results demonstrate that the educational value of Large Language Models extends beyond linguistic accuracy and encompasses broader communicative and affective dimensions of language learning (Zhang dkk., 2025). Improvements in pragmatic competence indicate that learners are capable of acquiring socially appropriate language behaviors through sustained interaction with AI-generated dialogue. Such outcomes reflect the growing capacity of artificial intelligence to simulate authentic communicative environments that support contextual language learning.

Reductions in speaking anxiety signify that emotional factors remain central to successful language acquisition. Learners often possess sufficient linguistic knowledge but hesitate to communicate because of psychological barriers (X. Wang & Hasim, 2024). Findings suggest that AI-mediated interactions can alleviate these concerns by creating an environment where mistakes are treated as opportunities for learning rather than sources of embarrassment. This characteristic may be particularly valuable for learners who lack confidence in traditional classroom settings.

Broader interpretation of the findings indicates that artificial intelligence should not be viewed solely as a technological innovation but also as a pedagogical resource capable of addressing longstanding challenges in language education. Development of communicative competence requires extensive exposure to meaningful interaction, while reduction of anxiety requires supportive learning conditions. AI-powered dialogue systems appear capable of contributing to both objectives simultaneously.

Long-term significance of these findings lies in their contribution to emerging discussions regarding the future of language education. Increasing accessibility of conversational AI technologies creates opportunities to personalize learning experiences, expand practice opportunities, and support learner autonomy. Educational stakeholders may therefore consider strategic integration of Large Language Models as part of a comprehensive approach to enhancing language learning outcomes.

Practical significance of this study lies in its demonstration that AI-powered dialogue systems can effectively address two persistent challenges in EFL education: insufficient pragmatic competence and high levels of speaking anxiety (X. Wang & Hasim, 2024). Evidence generated by this research suggests that learners benefit from frequent exposure to authentic conversational interactions facilitated by Large Language Models. Educational practitioners may therefore utilize

AI-assisted dialogue platforms as supplementary tools for improving communication skills and fostering learner confidence.

Pedagogical significance emerges from the capacity of AI systems to provide individualized learning opportunities that are difficult to achieve in conventional classroom environments. Continuous availability, adaptive feedback, and contextualized communication create conditions that support sustained language practice. Such characteristics may enhance the effectiveness of communicative language teaching approaches and expand opportunities for learner-centered instruction.

Theoretical significance relates to the growing body of literature on artificial intelligence in language learning. Findings contribute empirical evidence supporting the role of AI-mediated interaction in developing communicative competence and reducing affective barriers. Results also reinforce sociocultural perspectives emphasizing the importance of interaction and engagement in language acquisition processes.

Policy significance concerns the integration of emerging technologies into educational systems. Institutions and curriculum developers may consider incorporating AI-powered dialogue tools into language programs as part of broader digital transformation initiatives. Strategic implementation has the potential to enhance learning quality while preparing students for communication in increasingly technology-mediated environments.

Future research should investigate the long-term effects of AI-powered dialogue systems on communicative competence and language retention. Extended intervention periods may reveal whether improvements in pragmatic competence and reductions in speaking anxiety are sustained over time. Longitudinal studies would provide deeper insights into the durability of learning outcomes associated with AI-mediated communication.

Comparative investigations involving learners from different educational levels, cultural backgrounds, and language proficiency groups are necessary to determine the generalizability of the findings. Diverse participant populations would enable researchers to identify contextual factors influencing the effectiveness of Large Language Models in language education.

Exploration of additional language skills represents another important direction for future inquiry. Research may examine the impact of AI-powered dialogue systems on listening comprehension, pronunciation development, intercultural competence, and critical thinking. Broader examination of learning outcomes would contribute to a more comprehensive understanding of the educational potential of artificial intelligence.

Development of pedagogical frameworks integrating human instruction and AI-assisted learning constitutes a critical next step. Effective language education requires balancing technological innovation with meaningful human interaction. Future studies should therefore investigate optimal strategies for combining teacher guidance, peer communication, and AI-powered dialogue to maximize learning effectiveness and learner well-being.

CONCLUSION

The present study revealed several significant findings that extend beyond existing scholarship on technology-mediated language learning. Most notably, sustained interaction with Large Language Models (LLMs) demonstrably enhanced EFL learners' pragmatic competence, particularly in the domains of speech act realization, politeness strategy deployment, and contextual register appropriateness areas where conventional classroom instruction has historically proven insufficient. Unlike prior studies that examined LLM integration as a supplementary tool, this research established a statistically significant correlation between the frequency and depth of AI-

powered dialogic engagement and measurable gains in pragmatic awareness, suggesting that LLMs possess a distinctive capacity to simulate authentic communicative contexts that textbooks and teacher-fronted instruction cannot fully replicate. Equally noteworthy, speaking anxiety among EFL learners exhibited a marked and consistent decline across the intervention period, a finding attributable to the non-judgmental, infinitely patient interactional affordances unique to AI conversational agents.

This research contributes a dual theoretical and methodological advancement to the field of applied linguistics and computer-assisted language learning (CALL). Conceptually, it introduces an integrative framework termed the Pragmatic-Affective AI Dialogue Model (PAADM) which repositions LLMs not merely as linguistic tools but as affective scaffolding agents capable of simultaneously addressing cognitive and psychological dimensions of second language acquisition. Methodologically, the study pioneers the application of multimodal assessment instruments that triangulate pragmatic performance data with psychometric anxiety indices and interaction log analytics, offering the research community a replicable evaluative architecture for future investigations into AI-mediated language learning environments.

Notwithstanding the substantive contributions outlined above, several limitations circumscribe the generalizability of these findings and illuminate productive directions for subsequent inquiry. The study was conducted within a single institutional context with a relatively homogeneous participant sample, constraining the cross-cultural and cross-proficiency transferability of the results. Furthermore, the LLM models employed, while state-of-the-art at the time of data collection, did not incorporate real-time multimodal feedback mechanisms such as prosodic or paralinguistic cue processing, which are integral dimensions of authentic spoken pragmatics. Future research would benefit substantially from longitudinal designs spanning multiple academic years, comparative studies across culturally and linguistically diverse learner populations, and the integration of multimodal AI systems capable of processing and responding to non-verbal communicative signals thereby generating a more ecologically valid simulation of naturalistic human interaction.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used Grammarly to assist in improving grammar, language quality, and overall readability of the text. After using this tool, the author(s) carefully reviewed and edited the content as necessary and take full responsibility for the content of the publication.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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