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Research Article

Integrating generative AI into EFL writing: University students' strategies and perceptions

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ABSTRACT

This study examined how 59 English as a foreign language (EFL) students utilize generative artificial intelligence (AI) tools in English writing and their perceptions of AI-assisted instruction. Using pre- and post-intervention surveys, the quantitative research measured writing strategies across three dimensions and AI experiences. Results showed significant improvements in idea generation ($\eta^2 = .08$) and content refinement ($\eta^2 = .09$) strategies, with students frequently using translation applications (mean = 4.07) and AI tools (mean = 3.94) in conjunction with traditional resources. However, perceptions of AI tools remained stable ($p = .124$), indicating consistently positive attitudes. Findings suggest that AI is an effective supplementary tool for EFL writing, particularly for idea generation and content refinement, while students maintained a critical awareness of AI limitations and preferred AI as a complement to, rather than a replacement for traditional instruction. The study supports the balanced integration of AI in EFL curricula, promoting the reflective and ethical use of AI.

Keywords: generative AI, EFL writing, Korean university students, writing strategies, AI-assisted learning, English language education

INTRODUCTION

The advent of generative artificial intelligence (AI) has shown a dramatic shift in English language education, particularly within English as a foreign language (EFL) pedagogical contexts. Contemporary AI platforms, including ChatGPT and Grammarly, have transformed the landscape of linguistic learning by facilitating adaptive, real-time feedback and enabling personalized instructional systems (Chan & Hu, 2023; Cotton et al., 2023; Escalante et al., 2023; Gayed et al., 2022; Hong, 2024). These technological innovations represent a broader educational transformation where generative AI applications are increasingly integrated to enhance instructional efficacy and optimize learning outcomes across diverse academic domains.

The evolving capabilities of AI have expanded its pedagogical relevance within English language instruction. As sophisticated digital pedagogical agents, generative AI tools demonstrate the capacity to address the inquiries of English language learners (ELLs), provide comprehensive explanations, and establish cognitive scaffolding across multiple linguistic competency domains. Empirical studies have demonstrated the effectiveness of AI interventions in enhancing vocabulary acquisition, grammatical accuracy, writing fluency, learner motivation, and metacognitive self-regulation strategies (Hwang & Chen, 2023; Hwang et al., 2023; Im, 2024; Islam & Rahman, 2024; Jasim et al., 2024; Jeong, 2024).

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Generative AI technologies have shown benefits in diverse linguistic competencies among EFL learners. Recent research findings show the effectiveness of AI-assisted interventions in enhancing ELLs' written discourse production capabilities and reading comprehension proficiency (Jung, 2023; Lee & Davis, 2024; Lee et al., 2023; Liu et al., 2021; Shi & Aryadoust, 2024). Integrating AI within ELT environments has been associated with increased student engagement and enhanced motivation levels, thereby fostering a more interactive learning environment. Furthermore, ELT practitioners have expressed favorable perspectives on the implementation of AI tools, highlighting significant advantages, including improved instructional efficiency and enhanced learner performance outcomes (Mai et al., 2024; Park, 2024; Sevnarayan & Naidu, 2024; Shin, 2023).

However, generative AI technologies present substantial challenges concerning ethical utilization and maintenance of academic integrity. Critical concerns, including plagiarism, misinformation, and excessive reliance on AI systems, necessitate the establishment of comprehensive guidelines governing the responsible implementation of AI within ELT contexts (Barrot, 2023; Cao & Zhong, 2023; Choi, 2023; Lund et al., 2023). These ethical considerations underscore the imperative for balanced AI integration approaches that maximize pedagogical benefits while reducing potential risks associated with AI dependency and misuse.

Despite previous studies examining the general benefits and successful implementations of generative AI in EFL education, a gap persists in empirical research investigating the impact of AI on university-level English writing instruction. While existing literature has extensively documented AI's effectiveness in developing language skills, there remains insufficient empirical evidence regarding how ELLs strategically employ AI tools within authentic writing processes and how these interactions influence their metacognitive writing strategies and perceptions over time.

This research addresses the question by exploring the integration of generative AI into English writing education as a feedback-oriented pedagogical support mechanism. Specifically, this study examines the strategic use of AI tools by university EFL students within writing environments and investigates their evolving perceptions of AI-assisted writing instruction. The research objectives include three primary dimensions:

(1) exploring the specific writing strategies that EFL learners employ when utilizing AI-assisted writing environments, with particular attention to how these strategies evolve,

(2) examining learners' perceptions, attitudes, and experiences regarding AI- assisted writing instruction, and

(3) identifying the pedagogical implications of strategic AI integration for EFL writing curriculum development and instructional design.

This study aims to contribute to the development of informed applications of AI in EFL writing education by providing empirical evidence regarding ELLs' interactions with generative AI technologies within authentic writing tasks. The findings will inform evidence-based policies for the responsible and effective incorporation of AI tools into language education curricula, thereby advancing our understanding of AI integration strategies that enhance learning outcomes while maintaining academic integrity and promoting learner autonomy.

LITERATURE REVIEW

Theoretical Background

This study is grounded in two theoretical frameworks: cognitive load theory and Vygotsky's socio-cultural theory of the zone of proximal development (ZPD). Cognitive load theory posits that learning is optimized when instructional design reduces demands on working memory, thereby allowing learners to concentrate their limited cognitive resources on essential processing and higher-order problem solving. Within the context of English writing instruction, surface-level tasks such as grammar correction, spelling, or lexical choice often impose a cognitive burden on learners, leaving fewer resources available for more complex processes, including generating ideas, organizing arguments, and refining content. In this study, generative AI tools were expected to resolve part of this burden by simplifying routine aspects of writing. By reducing the mental effort associated with these lower-level processes, ELLs can focus their attention on idea generation and content refinement, both of which are central to the development of higher-order writing competence.

Vygotsky's concept of the ZPD offers a complementary perspective, emphasizing the role of mediation and scaffolding in enabling learners to accomplish tasks that they could not manage independently. The ZPD highlights the dynamic space between what ELLs can achieve and what becomes possible with the support of a more knowledgeable other or a mediating artifact (Cong-Lem & Daneshfar, 2024). Generative AI functions in this study as a mediating tool: by offering real-time feedback, paraphrasing, and model structures, it enhances students' capacity to transition from basic sentence-level writing to more complex, coherent, and contextually appropriate discourse (Ghimire et al., 2024). Taken together, cognitive load theory and the ZPD offer a dual lens for understanding how AI tools can reduce unnecessary mental strain while simultaneously expanding learners' developmental potential, thereby providing a theoretical foundation for investigating the pedagogical value of AI-assisted writing instruction.

Generative Artificial Intelligence in English Language Learning

Integrating generative AI technologies into EFL pedagogical frameworks represents a significant shift in contemporary language education. This technological evolution has been substantiated by an expanding body of empirical research examining the multifaceted applications of AI-assisted language learning interventions (Chan & Hu, 2023; Cotton et al., 2023; Escalante et al., 2023). The proliferation of assisted platforms, including ChatGPT, Grammarly, and QuillBot, has fundamentally transformed the landscape of second language acquisition by providing ELLs with access to instantaneous, personalized feedback mechanisms that facilitate real-time error correction and linguistic enhancement (Gayed et al., 2022; Hong, 2024; Hwang & Chen, 2023).

The theoretical underpinnings of AI-assisted language learning draw extensively from socio-cultural theories of second language acquisition, particularly Vygotsky's concept of the ZPD, wherein AI tools function as sophisticated mediating artifacts that bridge the gap between ELLs' current linguistic competence and their potential developmental trajectory (Hwang et al., 2023). Contemporary research has demonstrated that these digital pedagogical agents possess a remarkable capacity for providing scaffolded support across multiple dimensions of language competency, including lexical acquisition, syntactic accuracy, discourse organization, and pragmatic appropriateness (Im, 2024; Islam & Rahman, 2024; Jasim et al., 2024).

Artificial Intelligence-Assisted Writing Instruction

The application of generative AI technologies in EFL writing contexts has shown empirical evidence regarding their efficacy in enhancing the cognitive and metacognitive aspects of the composing process. Previous research has documented significant improvements in writing quality, self-efficacy beliefs, and self-regulated learning strategies among learners who engage with AI-assisted writing environments (Liu et al., 2021). These findings align with cognitive load theory, suggesting that AI tools effectively reduce cognitive burden while enhancing cognitive processing related to higher-order thinking skills such as critical analysis and creative ideation (Jeong, 2024; Jung, 2023).

Furthermore, empirical studies have demonstrated that AI-assisted writing instruction facilitates the development of metacognitive awareness by encouraging learners to critically evaluate their writing processes and products (Lee et al., 2023). This metacognitive enhancement is particularly significant in the revision and editing phases, where AI feedback facilitates learners' critical examination of their linguistic choices. However, it is noteworthy that the effectiveness of AI interventions appears to be mediated by individual learner characteristics, contextual factors, and the quality of pedagogical implementation, suggesting that the impact of generative AI on learner engagement and motivation may exhibit considerable variability across different educational contexts (Lee & Davis, 2024).

Student Perceptions and Attitudes Toward Artificial Intelligence Integration

Empirical investigations into learner attitudes toward assisted AI-writing instruction have consistently revealed positive perceptions among EFL students. Several studies have demonstrated that students report increased enjoyment, confidence, and perceived improvement in writing when utilizing AI tools in their academic writing endeavors (Shi & Aryadoust, 2024). These attitudinal benefits have been attributed to several key factors, including the provision of immediate feedback, reduction of writing anxiety, and enhancement of learner autonomy through personalized learning experiences.

Moreover, research has identified significant pedagogical advantages of integrating AI in writing curricula, including enhanced student engagement, individualized learning support, and improved access to writing resources (Mai et al., 2024). Students have particularly valued the capacity of AI tools to assist with brainstorming, topic development, and structural organization, suggesting that these technologies serve as valuable cognitive prostheses that augment rather than replace human cognitive processes in academic writing contexts.

Artificial Intelligence in Korean English as a Foreign Language Settings

The Korean higher education context presents an opportunity for investigating the pedagogical implications of integrating generative AI into EFL instruction. Korean EFL learners face unique linguistic challenges. Recent empirical studies conducted within Korean university settings have provided compelling evidence of the cognitive and affective benefits of assisted writing instruction.

For instance, Jung (2023) conducted a comprehensive investigation into the impact of ChatGPT on the writing development of university students, revealing that AI feedback provided substantial cognitive support across multiple dimensions of writing competency, including content development, organizational coherence, and linguistic precision. Students reported an increase in writing confidence and a greater motivation to engage in English writing tasks. However, the study also identified several areas of concern, including questions regarding the accuracy and reliability of AI-assisted suggestions, ethical implications related to academic integrity, and the potential risk of developing over-reliance on AI assistance, which could hinder the development of independent writing skills.

Complementary research has demonstrated that Korean EFL learners in assisted instructional environments exhibit significantly improved writing performance and emotional satisfaction compared to their counterparts in traditional teacher-led writing courses (Park, 2024). These findings suggest that AI tools can effectively complement conventional pedagogical approaches by providing additional support that addresses individual learner needs and preferences. Furthermore, empirical evidence indicates that generative AI technologies are particularly effective in supporting the ideation and revision phases of the writing process, enabling students to generate more sophisticated content and engage in more systematic revision strategies (Shin, 2023).

Given the identified research gaps and the need for a more comprehensive understanding of AI integration in EFL writing contexts, the present investigation addresses the following research questions (RQs):

RQ1: What writing strategies do university EFL learners employ when utilizing AI-assisted writing environments?

RQ2: How do university EFL learners perceive and evaluate their experiences with assisted writing instruction?

This research aims to contribute to the theoretical understanding of AI-assisted language learning by providing empirical evidence on the complex interactions between ELLs, AI technologies, and pedagogical contexts in authentic EFL writing environments. The findings will inform the development of evidence-based guidelines for the ethical and practical integration of AI tools in language education curricula, thereby advancing the field's understanding of implementation strategies that enhance pedagogical benefits while mitigating potential risks associated with AI dependency and misuse.

RESEARCH METHOD

How Artificial Intelligence was Implemented in ELT Classrooms

This course, offered as a core liberal arts requirement, was deliberately designed to incorporate generative AI tools as a means of supporting English language development across the four skills. The instructional design was guided by Vygotsky's notion of the ZPD, which provides scaffolding that enables ELLs to accomplish tasks beyond their independent capabilities. For listening, NotebookLM was employed to provide podcasts accompanied by supplementary explanations and summaries. This design allowed students to engage with authentic input while benefiting from structured support that expanded their comprehension skills within

Table 1. Demographic data of survey participants

Category		Frequency (N = 59)	Percentage (%)
Gender	Male	49	83.0
	Female	10	17.0
Grades	Freshman	55	93.2
	Sophomore	1	1.7
	Junior	1	1.7
	Senior	2	3.4
Majors	STEM-related	29	53.7
	Natural science	1	1.9
	Department of interdisciplinary major	22	40.7
	Department of smart infrastructure engineering	1	1.9
	Software department	1	1.9
AI utilization experience	Yes	117	31.5
	No	37	65.8

their ZPD. Speaking practice was facilitated through SoulMachines.com, where students interacted with avatars in a low-stakes environment that encouraged repeated rehearsal and experimentation with language. These interactions created opportunities for ELLs to practice new forms and expressions with immediate feedback, thereby lowering the barrier to oral production and extending their communicative competence.

In writing, students drafted their own compositions and then engaged in a revision process using Grammarly. The tool provided targeted feedback on grammar and clarity, reducing the effort required for self-editing. It should be noted, however, that this reduction in mental effort was inferred from ELLs ' reports rather than directly observed. Quillbot was also used to provide paraphrasing models, enabling students to refine their expression and reflect more critically on their stylistic choices.

These AI tools supported revision practices that many students would have struggled to sustain on their own. While the course demonstrates the potential of generative AI to create meaningful learning opportunities within students' ZPD, further work is needed to determine how these supports function across the whole writing process and how they may be balanced with the development of independent learning strategies.

Study Participants

The study included 59 university-level ELLs enrolled in an English writing course in Spring 2025. The sample consisted of 49 male students (83%) and 10 female students (17%). Regarding academic year, the vast majority of students (n = 55, 93.2%) were in their first year, while only one student each was in the second (1.6%) and third (1.6%) years, and two students (3.4%) were in the fourth year. This distribution aligns with the course's enrollment pattern, primarily including freshmen from introductory-level classes.

Regarding academic majors, 29 students (53.7%) were from STEM-related fields, including natural sciences and engineering. Within this group, 1 student (1.9%) majored in natural sciences, 1 (1.9%) in smart infrastructure engineering, and 1 (1.9%) in the software department. 22 students (40.7%) were affiliated with the department of interdisciplinary majors, which allows students to design interdisciplinary programs focused on emerging technologies and convergence studies. Regarding prior experience with AI tools, only 17 students (31.5%) reported using AI in educational settings, whereas 37 students (68.5%) indicated no such experience. **Table 1** shows the demographic information about survey participants.

All participants were informed of the study's aims and procedures, and their participation was entirely voluntary. Informed consent was obtained before data collection, and participants were assured that they could withdraw from the study at any time without academic penalty. To maintain confidentiality, personal identifiers were removed, and all data were anonymized and coded before analysis. The research team took particular care to ensure academic integrity and to protect the privacy of student work. All information collected was stored securely and used solely for research purposes.

Survey Instruments

This study used a quantitative research design to investigate students' English writing strategies and experiences with generative AI tools. The first instrument was a modified version of a previously validated

survey (Park, 2024), which was adapted to measure the usability and convenience of AI tools and writing strategies for English writing among EFL students. The survey consisted of 19 questions, divided into three subscales: idea generation (9 questions), grammar correction (3 questions), and content refinement (7 questions). A Cronbach's alpha was calculated to assess the internal consistency of the subscales. The analysis revealed questionable reliability for the idea generation subscale (α = .68), while the grammar correction (α = .76) and content refinement (α = .72) subscales showed acceptable internal consistency. For the English writing strategy questionnaire, examples included statements such as "when writing in English, I think in Korean first and then write in English" and "when writing in English, I use an online Korean-English dictionary."

A second, 15-item survey was adopted (Lee, 2024) to evaluate students' experiences with generative AI. The survey was constructed to capture multiple dimensions of learners' experiences. Specifically, it included three items assessing the perceived usefulness and convenience of ChatGPT during the English writing process, three items evaluating its overall effectiveness, and three items examining whether learners believed that AI contributed to the improvement of their English language proficiency. In addition, six items were devoted to measuring learners' satisfaction with their experiences of AI-assisted writing instruction. The instrument demonstrated good internal consistency (α = .87). Both instruments employed a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The surveys were administered online at the beginning and end of the semester to assess changes in students' writing strategies and their perceptions of AI-assisted writing. The experience questionnaire featured statements such as "I am satisfied with the corrective feedback from ChatGPT" and "using ChatGPT has reduced my fear of English writing." These examples illustrate the range of constructs assessed across the three instruments.

STUDY RESULTS

Usability and Convenience

A within-subjects MANOVA was conducted to analyze the usability and convenience of AI tools and writing strategies across the three subscales of idea generation, grammar correction, and content refinement. Due to a significant Box's M test ($p < .001$), Pillai's trace was used to analyze the pre- and post-tests of the three subscales. The analysis revealed a significant multivariate effect, $V = .125$, $F(3,114) = 5.429$, $p = .002$, with a moderate effect size ($\eta^2 = .125$) and high statistical power (observed power = .930).

Post hoc test indicated that there were significant differences between pre- and post-test in the idea generation ($F[1, 116] = 9.70$, $p = .002$; $\eta^2 = .08$) and content refinement ($F[1, 116] = 11.23$, $p = .001$; $\eta^2 = .09$), with post-test scores rated significantly higher in both assessments. However, no significant differences were observed in the pre- and post-test comparison for grammar correction.

Generative Artificial Intelligence Experiences

A paired t-test was conducted to evaluate students' pre- and post-test experiences. The results indicated no significant difference ($t[58] = -1.24$, $p = 0.16$) between the pre- and post-test scores. See **Table 2** for the means and standard deviations of all pre- and post-test measures.

DISCUSSION

The findings of this investigation provide empirical evidence for the pedagogical efficacy of integrating generative AI in university EFL writing contexts, while revealing patterns of student engagement and strategic utilization that need careful examination. The results align with existing theoretical frameworks, while also exploring previously unexplored dimensions of assisted writing instruction.

Strategic Utilization Patterns and Cognitive Load Theory

The significant improvements observed in idea generation ($\eta^2 = .08$) and content refinement ($\eta^2 = .09$) strategies provide substantial support for the application of cognitive load theory in AI-assisted writing environments. These findings corroborate Jung's (2023) observations regarding AI's capacity to provide cognitive support across multiple dimensions of writing competency, while extending our understanding of how such support manifests in measurable strategic behaviors. The moderate effect sizes suggest that AI

Table 2. Descriptive statistics for pre- and post-test measures

Category		Mean	Standard deviation
Idea generation	Pre-test	3.42	0.45
	Post-test	3.69	0.51
Grammar correction	Pre-test	3.73	0.75
	Post-test	3.73	0.51
Content refinement	Pre-test	3.29	0.67
	Post-test	3.69	0.62
AI experiences	Pre-test	52.45	9.07
	Post-test	53.85	9.33

tools function as an effective cognitive process, reducing cognitive burden while enabling learners to allocate greater mental resources to higher-order thinking processes such as creative ideation and rhetorical decision-making, as theorized by Jeong (2024).

In EFL writing, even relatively small gains can make a tangible difference to ELLs' ability to initiate and develop their work. An increase of just over a quarter of a point on a five-point scale in idea generation indicates that students became more willing and able to move past the initial hurdle of producing content–a stage that many learners find particularly challenging. Likewise, the improvement in content refinement suggests that students engaged more actively in revising their drafts, demonstrating a greater readiness to reorganize ideas and strengthen arguments rather than stopping at a first version. These patterns are noteworthy because higher-order writing skills, such as brainstorming and revision, are not easily improved through short-term instruction. The fact that students showed measurable progress in these areas suggests that AI tools can play a meaningful role in encouraging the kinds of strategic behaviors that support long-term writing development. At the same time, the modest size of the gains serves as a reminder that AI should not be viewed as a transformative solution in isolation. Instead, these tools are best understood as supplementary supports that can gradually foster more effective writing habits when integrated thoughtfully into the curriculum.

The absence of significant improvement in grammar correction strategies ($p > .05$) presents a counterpoint to existing literature and careful consideration. While previous studies have emphasized AI's effectiveness in enhancing grammatical accuracy (Hwang & Chen, 2023; Islam & Rahman, 2024), this finding challenges the assumption that AI tools uniformly improve all dimensions of writing competency. It suggests their effectiveness may be domain-specific and contingent upon learners' proficiency levels.

Socio-Cultural Mediation and Digital Tool Integration

The results validate the application of Vygotskian socio-cultural theory to AI-assisted language learning contexts. The significant improvements in idea generation and content refinement suggest that AI tools effectively function as sophisticated mediating artifacts within learners' ZPD, facilitating the transition from current writing competence to enhanced performance levels. This interpretation aligns with Hwang et al.'s (2023) theoretical framework while providing quantitative evidence for AI's mediational capacity in authentic writing tasks.

The high utilization rates of translation applications and assisted tools indicate that EFL learners employ AI as part of a broader, integrated toolkit that includes bilingual composition strategies and L1 mediation. This finding aligns with Park's (2024) observations regarding the strategic deployment of multiple resources by ELLs, while extending our understanding of how AI tools are integrated into existing multilingual writing practices. Integrating AI tools alongside traditional resources suggests that learners are developing sophisticated strategies that maximize the benefits of technological mediation while maintaining a connection to familiar linguistic resources.

Attitudinal Stability and Pedagogical Implications

The absence of significant changes in students' overall perceptions of AI tools presents a particularly noteworthy finding that confirms and challenges existing literature. This result aligns with Shi and Aryadoust's (2024) documentation of consistently positive attitudes toward AI-assisted writing instructions, suggesting that initial favorable perceptions persist even after extended exposure to AI-assisted environments. However,

this finding also suggests that attitudinal benefits indicate that the primary value of AI integration lies in strategic enhancement rather than motivational transformation. The maintained positive attitudes and strategic improvements support the theoretical proposition that AI tools serve as effective supplements rather than replacements for traditional instruction, as Mai et al. (2024) advocated. This finding has significant implications for curriculum design, suggesting that AI integration should be conceptualized as an enhancement to existing pedagogical frameworks rather than a transformation of instructional practice.

Metacognitive Development and Scaffolded Support

The observed improvements in idea generation and content refinement strategies provide evidence for AI's capacity to facilitate metacognitive development, supporting Lee et al.'s (2023) assertions regarding AI's role in encouraging critical evaluation of writing processes. The enhancement of these higher-order writing strategies suggests that AI tools enable ELLs to engage more systematically with the conceptual and organizational aspects of academic writing, potentially addressing the unique challenges EFL learners face in navigating English conventions and discourse patterns. The differential impact across writing strategy dimensions indicates that AI's scaffolding effects are not uniform but rather align with the specific cognitive demands of different writing phases. The pronounced effects on idea generation and content refinement suggest that AI tools are particularly effective in supporting the creative and revision phases of writing, where learners benefit most from external cognitive support and alternative perspectives.

CONCLUSIONS

This study has provided empirical evidence for the strategic integration of generative AI technologies in university EFL writing contexts, revealing both the pedagogical potential and the complexities of assisted language instruction. The study's findings demonstrate that Korean EFL learners effectively utilize AI tools as cognitive support to enhance specific dimensions of writing competency, particularly in the processes of idea generation and content refinement. The significant improvements observed in these strategic domains suggest that AI technologies function as mediating artifacts within Vygotsky's ZPD, facilitating learners' transition from current writing abilities to enhanced performance levels. However, the absence of significant improvement in grammar correction strategies indicates that AI's pedagogical efficacy is domain-specific rather than uniformly transformative, challenging assumptions about comprehensive AI effectiveness across all writing competencies.

The research contributes to the theoretical understanding of AI-assisted language learning by demonstrating how EFL learners strategically orchestrate multiple technological and traditional resources within their writing practices. The high utilization rates of AI tools and translation applications alongside conventional resources suggest that learners develop multilingual composition strategies that integrate AI capabilities with existing linguistic knowledge and cultural discourse patterns. Notably, ELLs' perceptions throughout the intervention period indicate that positive attitudes toward AI integration remain consistent over time, supporting the conceptualization of AI tools as effective supplements rather than replacements for traditional pedagogical approaches. This finding has significant implications for curriculum design, suggesting that AI integration should be positioned as an enhancement to existing instructional frameworks rather than a transformation of educational practice.

The pedagogical implications of these findings extend beyond immediate classroom applications to encompass broader considerations of ethical AI implementation and learner autonomy development in EFL contexts. The study's evidence for AI's effectiveness in supporting higher-order cognitive processes while maintaining positive learner attitudes provides a foundation for developing evidence-based guidelines for the responsible integration of AI in language education curricula. Future research should investigate the longitudinal effects of sustained AI utilization on independent writing skill development, explore the balance between AI assistance and learner autonomy, and examine how individual learner characteristics mediate the effectiveness of AI interventions across diverse EFL populations. These insights will be crucial for advancing our understanding of how AI technologies can be strategically leveraged to enhance language learning outcomes while preserving academic integrity and fostering critical digital literacy skills among EFL learners.

Limitations

This study has several limitations that have to be considered. The gender distribution exhibited extreme imbalance, with male students comprising 83% and female students representing only 17% of participants. Similarly, the academic year distribution was highly skewed, with first-year students comprising 93.2% of the sample, thereby failing to adequately capture diverse perspectives across different academic levels. Furthermore, the concentration of participants in STEM-related fields (53.7%) precluded comprehensive representation of humanities and social sciences majors, whose AI utilization patterns and perceptions may differ substantially. This sample homogeneity limits the applicability of the findings to EFL learners of different genders, academic years, and disciplinary backgrounds, thereby reducing the external validity of the research outcomes.

Also, the limitation of this study is the absence of a control group. For instance, improvements in content development, organization, or revision practices could be the result of students' growing familiarity with academic writing through repeated practice, rather than the direct effect of AI interventions. While the present findings provide valuable insight into students' perceptions and experiences, they should therefore be interpreted with caution. Future research would benefit from adopting more rigorous designs that include either a control group receiving conventional instruction or a pre-test/post-test comparison. Such approaches would enable stronger causal interpretations by distinguishing the specific effects of AI integration from more general developmental gains. Incorporating these design elements would not only strengthen the internal validity of subsequent studies but also provide more evidence of when and how generative AI tools most effectively support student learning.

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Data availability: Data generated or analyzed during this study are available from the authors on request.

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