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THE EFFECT OF AI-ASSISTED WRITING ON STUDENTS' ACADEMIC WRITING SKILLS

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Abstract: In higher education, the integration of artificial intelligence (AI) has experienced rapid development. However, empirical evidence regarding the effectiveness of AI in improving students' academic writing skills remains limited, particularly in Indonesia. This quasi-experimental study investigated the effect of AI-assisted writing instruction on the academic writing proficiency of undergraduate English as a Foreign Language (EFL) students at Universitas Muhammadiyah Palopo. This study involved 60 students divided into two groups: an experimental group and a control group. Students' writing was assessed using a validated rubric that focused on four aspects: content and organization, grammar and mechanics, vocabulary and style, and citations and references. The instrument demonstrated strong inter-rater reliability (Cohen's $\kappa = 0.87$). The results showed that the experimental group achieved significantly higher scores than the control group. These results were analysed using an analysis of covariance (ANCOVA). This can be seen from the higher scores (Cohen's $d = 2.00$) and (N-Gain = 0.42) in the experimental group compared to the control group, which achieved (N-Gain = 0.20). Furthermore, data from the perception questionnaire (Cronbach's $\alpha = 0.84$) indicated that most students responded positively to the use of AI tools. Reported benefits included increased writing efficiency, improved grammatical accuracy, and better organization of ideas. However, some participants also expressed concerns about the risk of over-reliance on the technology. Overall, the findings suggest that AI-assisted writing instruction, when implemented within a structured and targeted pedagogical approach, can significantly improve academic writing skills in EFL higher education contexts. These results offer practical implications for curriculum design and teaching strategies.
Keywords: *AI-assisted writing; academic writing skills; EFL; higher education; Indonesia.*

INTRODUCTION

Academic writing represents a fundamental competency in higher education because it enables learners to communicate disciplinary knowledge through evidence-based and analytically structured arguments (Deep, 2025; Hyland, 2019; Jo'rayeva, 2024; Stritch, 2025). It enables students to articulate logical and evidence-based arguments and engage in scholarly communication (Hilario et al., 2025; Mlundi, 2026; Ramadhan et al., 2024; Taye, 2024). It functions as a central channel through which knowledge is constructed, examined, and shared across disciplines (Tusting et al., 2019). For this reason, proficiency in academic writing reflects not only linguistic ability but also advanced cognitive skills, such as critical thinking, synthesis of information, and structured argumentation (Nugroho et al., 2024).

In English as a Foreign Language (EFL) contexts, however, the development of this competency is particularly demanding (Rao, 2020; Zhang, 2021). Learners are required to balance multiple challenges simultaneously, including maintaining grammatical accuracy, selecting appropriate vocabulary, and following established conventions of academic discourse in a language that is not their first (Bitchener & Ferris, 2021; Hyland & Jiang, 2021). These demands often make the process of acquiring academic writing skills more complex and time-intensive compared to native language contexts(I. Lee, 2020; Nguyen & Habók, 2023).

Within the Indonesian context, these challenges are particularly pronounced. In many EFL situations, students have limited exposure to English outside the classroom, which restricts their ability to develop academic writing proficiency (Elmezughi & Zidan, 2026), which reduces their opportunities to internalize the conventions of academic language use. In addition, differences between local rhetorical traditions and the expectations of English academic writing further complicate the learning process (Chuikova, 2020). Whereas local writing practices may tolerate more implicit forms of argumentation, English academic discourse typically requires clearly stated thesis statements, logical sequencing of ideas, and well-structured organization (Jaya, 2025).

This study is grounded in Sociocultural Theory (Vygotsky, 1978), which views learning as a socially mediated process shaped by interaction and the use of cultural tools. Central to this theory are the concepts of mediation and the Zone of Proximal Development (ZPD), which describes the gap between what learners can do independently and what they can achieve with support. In academic writing, this suggests that development is facilitated through scaffolding provided by external tools. Accordingly, AI-powered writing tools such as Grammarly, QuillBot, and ChatGPT are conceptualized as mediating artifacts that support learners within their ZPD by providing feedback and guidance to enhance their writing performance.

Across the existing literature, there is a strong convergence of findings indicating that AI tools consistently support improvements in students' writing performance. This pattern is evident in the increasing integration of AI-based tools such as Grammarly, QuillBot, and ChatGPT in higher education, which provide forms of feedback that extend beyond traditional instructional approaches (Raheem et al., 2023) (Valdev Singh et al., 2026). At the level of grammatical accuracy, AI-powered grammar and style checkers systematically analyze linguistic patterns, identify surface-level errors, and generate targeted suggestions that enhance clarity, readability, and overall correctness (Fajardo Taday, 2025; Graham & Milan, 2025; Rahman, 2026). Consistent with this trend, multiple studies report that students who engage with such tools produce writing with fewer grammatical errors and demonstrate increased awareness of academic writing conventions (Alsaedi, 2024; Begmatova & Saydazimova, 2026; Mohd Sham et al., 2025).

Beyond surface-level correction, more advanced AI technologies particularly generative large language models have been associated with improvements in higher-order writing skills (Aslam et al., 2025). Their use has been linked to better organization of ideas, more coherent argument development, and stronger overall text structure, while paraphrasing tools help students diversify their vocabulary and rephrase ideas with greater sophistication (Tamilselvi et al., 2023)AI tools have also been connected to the development of learner autonomy, as the ability to independently detect and revise errors encourages more self-directed approaches to learning (Achuthan, 2025; Mohebbi, 2025; Umar & Purwanto, 2025; Yang et al., 2025)

However, despite these reported benefits, emerging discussions in the literature suggest that such improvements may not be uniform across all dimensions of writing competence, particularly when it comes to deeper critical and rhetorical skills.

As reflected in the broader literature, student perceptions of AI writing tools have been broadly positive (Chen, 2025; Demirel, 2024; Y.-J. Lee et al., 2024). Learners report greater confidence, increased writing efficiency, and a sense of structured support that eases the writing process (Marzuki et al., 2023; Munawwaroh & Fahreza, n.d.). Yet the same literature also surfaces important limitations and contradictions. AI-based tools tend to concentrate on linguistic accuracy and surface features, and may fall short in supporting the deeper conceptual dimensions of writing—among them critical thinking, rhetorical awareness, and the construction of well-reasoned arguments (Begmatova & Saydazimova, 2025). Concerns have equally been raised about over-reliance on automated feedback, which risks shifting students' attention toward surface error correction at the expense of reflective, analytical engagement, as well as about academic integrity when generative AI is used without adequate guidance or transparency (Gerlich, 2025)

A critical review of the literature further highlights several gaps that remain insufficiently addressed. This gap is particularly evident in Indonesian EFL higher education, where robust empirical evidence on the effectiveness of AI-assisted writing instruction remains scarce. As digital technologies are increasingly woven into institutional teaching practices, the absence of a strong evidence base makes it difficult to determine how AI tools can be most effectively deployed to support student learning.

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In addition to conceptual debates surrounding the effectiveness of AI in writing instruction, previous studies also exhibit several methodological limitations. A considerable number of studies rely heavily on self-reported data and student perceptions, which may introduce subjectivity and bias in evaluating actual writing improvement. Furthermore, many studies employ small sample sizes and short intervention periods, limiting the generalizability and long-term validity of their findings. In some cases, the absence of robust experimental or quasi-experimental designs makes it difficult to establish clear causal relationships between AI-assisted writing and measurable improvements in writing performance.

To address this gap, the present study investigates the effect of AI-assisted writing instruction on the academic writing skills of undergraduate EFL students. Specifically, this study seeks to answer two research questions: (1) Is there a significant effect of AI-assisted writing on students' academic writing skills? and (2) How do students perceive AI-assisted writing tools? This study offers several novel contributions by employing a quasi-experimental design with ANCOVA analysis to establish causal relationships, focusing on the underrepresented Indonesian EFL higher education context, and integrating both quantitative performance data and student perception data to provide a more comprehensive understanding of AI-assisted writing. The findings are expected to contribute theoretically by clarifying the role of AI as a mediating tool in writing development, practically by providing guidance for lecturers in integrating AI into writing instruction, and at the policy level by informing institutional strategies for the responsible and effective use of AI in higher education.

METHOD

This study employed a quasi-experimental design with a non-equivalent control group pre-test–post-test structure. This design was selected because random assignment of participants was not feasible due to intact classroom constraints (Creswell & Creswell, 2018). Two existing class sections from the same cohort, program, and semester were assigned to the experimental group and control group, respectively. The EG received AI-assisted writing instruction over eight weeks of treatment, while the CG followed the standard Academic Writing course curriculum without AI tool integration. The design is illustrated in Figure 1.

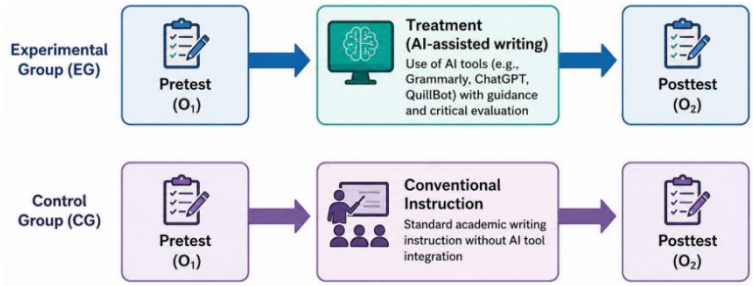


Figure 1. *Quasi-experimental pretest–posttest control group design*

The participants were 60 undergraduate students enrolled in an Academic Writing course at Universitas Muhammadiyah Palopo. The study involved two intact classes, consisting of 30 students in the experimental group and 30 students in the control group, selected through purposive sampling based on similarities in program, semester, and curriculum. Pre-test analysis using an independent-samples t-test indicated no significant differences between the two groups at baseline ($p > .05$), confirming their initial equivalence before treatment.

Students' academic writing skills were assessed using an analytic rubric adapted from the ESL Composition Profile and the TOEFL iBT rubric developed by Educational Testing Service (Service, 2019).The rubric covered four aspects: content and organization (30%), grammar and mechanics (25%), vocabulary and style (25%), and citation and referencing (20%), with a total score of 100. The instrument showed strong validity (CVI = .92) and reliability (Cohen's $\kappa = .87$).

Then students' perceptions were measured using a 20-item Likert-scale questionnaire covering five areas: writing efficiency, grammar, idea organization, confidence, and overreliance. The reliability of the questionnaire was acceptable (Cronbach's $\alpha = .84$). It was given only to the experimental group at the end of the study.

The treatment lasted eight weeks (16 sessions). In the first week, students in the experimental group were trained to use Grammarly, ChatGPT,

and QuillBot as writing support tools. They were guided to use AI critically, not as a substitute for their own writing. From Weeks 2 to 8, students followed a writing cycle: drafting, receiving AI feedback, revising, and submitting final work. They completed four tasks: a descriptive paragraph, an essay outline, a literature review section, and a full essay. The control group completed the same tasks but used only teacher and peer feedback.

Data were analysed using descriptive statistics (mean and standard deviation) and inferential statistics. Independent-samples t-tests were used to check group equivalence. ANCOVA was used to examine differences in post-test scores while controlling for pre-test scores. Effect size was calculated using Cohen's d, and learning improvement was measured using N-Gain. Questionnaire data were analysed using percentages. All analyses were conducted using IBM SPSS Statistics 27 with a significance level of $\alpha = .05$.

RESULTS AND DISCUSSION

Pre-test equivalence between groups

Independent-samples t-tests confirmed that the EG and CG did not differ significantly on any pre-test measure prior to the treatment. For overall pre-test scores, $t(58) = -1.15$, $p = .256$; for English proficiency, $t(58) = -0.23$, $p = .820$; and for prior GPA, $t(58) = 0.42$, $p = .676$. These results indicate that the two groups were statistically equivalent at baseline, supporting the attribution of post-test differences to the experimental treatment.

Effect of AI-assisted writing instruction on academic writing skills

Prior to conducting ANCOVA, preliminary assumption testing was performed. Normality of residuals was assessed using the Shapiro–Wilk test for each writing dimension, and all results were non-significant ($p > .05$), indicating no violation of the normality assumption. Homogeneity of regression slopes was examined through the interaction between pre-test scores and group assignment, which was not statistically significant ($F(1, 56) = 1.24$, $p = .271$). Additionally, Levene's test for equality of error variances was conducted and yielded non-significant results ($F(1, 58) = 1.86$, $p = .178$), confirming that the assumption of homogeneity of variance was met.

Table 1 presents the pre-test and post-test means, standard deviations, ANCOVA significance values, and Cohen's d effect sizes for each writing dimension and overall score.

Table 1. *Pre-test and post-test scores by group, Ancova results, and effect sizes*

Writing Dimension	EG Pre M (SD)	EG Post M (SD)	CG Pre M (SD)	CG Post M (SD)	p	Cohen's d	95% CI
Content & Organization (30%)	58.60 (7.65)	75.54 (7.96)	58.96 (9.01)	67.50 (9.07)	.001*	0.94	[0.55, 1.65]
Grammar & Mechanics (25%)	56.70 (8.47)	75.17 (8.80)	60.51 (8.38)	67.80 (8.84)	.002*	0.84	[0.31, 1.37]
Vocabulary & Style (25%)	59.30 (8.39)	77.03 (8.72)	58.78 (7.84)	66.90 (8.11)	<.001*	1.20	[0.65, 1.75]
Citation & Referencing (20%)	53.98 (8.96)	72.43 (8.74)	55.44 (10.54)	64.07 (10.68)	.001*	0.86	[0.33, 1.39]
Overall Score (Weighted)	57.38 (3.98)	75.20 (3.89)	58.60 (4.28)	66.74 (4.53)	<.001*	2.00	[1.35, 2.65]

ANCOVA results demonstrated that the EG achieved statistically significantly higher post-test score s than the CG across all four writing dimensions following the eight-week treatment. The largest effect was observed for Vocabulary and Style ($d = 1.20$), followed by Content and Organization ($d = 0.94$), Citation and Referencing ($d = 0.86$), and Grammar and Mechanics ($d = 0.84$). All effects exceeded the conventional threshold for a large effect ($d > 0.80$; Cohen, 1988). The overall weighted score yielded an effect size of $d = 2.00$, reflecting a substantial and educationally meaningful advantage for the AI-assisted instruction group.

Table 2 presents normalized gain (N-Gain) scores, providing a standardized index of within-group learning progress from pre-test to post-test.

Table 2. *Normalized Gain (N-Gain) scores by writing dimension and group*

Writing Dimension	EG N-Gain	CG N-Gain	Interpretation (EG | CG)
Content & Organization	0.41	0.21	Medium | Low
Grammar & Mechanics	0.43	0.19	Medium | Low
Vocabulary & Style	0.43	0.20	Medium | Low
Citation & Referencing	0.40	0.19	Medium | Low
Overall Score	0.42	0.20	Medium | Low

The EG demonstrated medium N-Gain across all dimensions (range: 0.40–0.43; overall N-Gain = 0.42), while the CG exhibited uniformly low N-Gain (range: 0.19–0.21; overall N-Gain = 0.20). These results indicate that AI-assisted instruction produced learning gains more than twice those achieved under conventional instruction, confirming a substantive pedagogical effect.

Students' perceptions of AI writing tools

Table 3 presents the distribution of student responses to the perception questionnaire administered to the experimental group at the conclusion of the treatment.

Table 3. *Student perceptions of AI writing tools (experimental group, n = 30.*
Note. SS = Strongly Agree, S = Agree, N = Neutral, TS = Disagree, STS = Strongly Disagree.

Statement	SS (%)	S (%)	N (%)	TS (%)	STS (%)	Mean
AI tools helped me write more efficiently	40.0	43.3	10.0	6.7	0.0	4.17
AI feedback improved my grammatical accuracy	46.7	36.7	13.3	3.3	0.0	4.27
AI tools helped me organize ideas better	33.3	46.7	13.3	6.7	0.0	4.07
I am more confident in academic writing now	30.0	50.0	16.7	3.3	0.0	4.07
AI writing tools are relevant for academic tasks	36.7	43.3	16.7	3.3	0.0	4.13
I worry AI use reduces my critical thinking	6.7	23.3	33.3	26.7	10.0	2.90
I would recommend AI tools to other students	33.3	46.7	13.3	6.7	0.0	4.07

The majority of experimental group students reported positive perceptions of AI writing tools. Over 80% agreed or strongly agreed that AI tools enhanced their writing efficiency (83.3%) and grammatical accuracy (83.4%), and 80% agreed that AI tools helped them organize ideas more effectively. Approximately 80% expressed increased confidence in academic writing following the treatment. Notably, 30.0% of students agreed or strongly agreed that AI use might reduce their critical thinking skills (Mean = 2.90), while the remaining 70% were neutral or disagreed with this concern, suggesting that the majority did not perceive AI as cognitively harmful when used within the scaffolded instructional framework.

The findings of this study provide empirical evidence that AI-assisted academic writing instruction is effective in improving students' writing performance. This is demonstrated by statistically significant differences between the experimental group (EG) and the control group (CG) across all four assessed dimensions, with large effect sizes and confidence intervals that do not include zero, thereby confirming the robustness of these effects.

These results are consistent with previous studies, including (Alsaedi, 2024), which found that AI tools such as Grammarly can improve grammatical accuracy, and Yan, who reported that the use of ChatGPT enhances coherence in writing. However, the present study further reveals that

integrating multiple AI tools in academic writing instruction yields more optimal results than relying on a single tool alone.

It should be noted, however, that not all studies have reported uniformly positive effects of AI on writing outcomes. For example, Begmatova and Saydazimova (2025) found that AI-assisted instruction, while effective for surface-level features such as grammar and vocabulary, did not consistently outperform conventional approaches in supporting deeper argumentation quality. These findings suggest that AI's effectiveness may be moderated by contextual factors such as task type, learner proficiency level, and the quality of instructional design. The consistently positive outcomes observed in the present study may therefore be partially explained by the structured eight-week intervention, the use of multiple complementary AI tools, and the explicit training provided to students on the critical evaluation of AI-generated feedback. This underscores that AI-assisted writing instruction is not inherently superior but depends on how thoughtfully it is designed and implemented.

Based on these findings, it can be concluded that AI supports different aspects of writing development. The largest effect was observed in the Vocabulary and Style dimension (d = 1.20), which aligns with the capacity of tools such as QuillBot and ChatGPT to generate diverse and contextually appropriate lexical alternatives a level of personalized support that is difficult to replicate in traditional classroom settings where a single instructor serves thirty or more students (Tajik, 2025). Students interacting with these tools are exposed to a wide range of synonymous expressions and stylistic options in real time, and the iterative nature of AI feedback cycles actively encourages lexical experimentation. The relatively smaller, though still large, effect for Grammar and Mechanics (d = 0.84) may reflect a ceiling effect, as syntactic acquisition tends to develop gradually and requires sustained exposure beyond what can be consolidated within an eight-week instructional period, even with AI support.

The improvement in the Citation and Referencing dimension (d = 0.86) is particularly noteworthy in the Indonesian EFL context. Referencing conventions are rule-based and highly structured, making them well-suited to AI-guided instruction. Tools such as ChatGPT and Grammarly can present correct citation formats clearly and repeatedly, enabling students to observe, imitate, and gradually internalize these conventions through practice. This is significant because unfamiliarity with citation norms is often identified as a key factor contributing to unintentional plagiarism among Indonesian EFL students (AbuSa'aleek, 2026; Anderson, 2009), and the findings of this study suggest that AI-assisted instruction may offer a practical and scalable solution to this issue.

The N-Gain results further clarify the learning patterns in both groups. The EG's overall medium N-Gain (0.42) indicates that students made meaningful progress during the eight-week period, while also suggesting that substantial room for further development remains. This should not be interpreted as a weakness of the intervention, but rather as a realistic reflection of how complex writing skills develop over time. Academic writing is not acquired within a single semester; it evolves through repeated cycles of practice, feedback, and revision across multiple courses and years of study. From this perspective, a medium N-Gain represents a strong outcome for an eight-week intervention. The CG's low but consistent gains (N-Gain = 0.20) further support this interpretation. Conventional instruction involving teacher and peer feedback did result in measurable improvement, confirming that the baseline pedagogical condition was functional. Therefore, the superior gains observed in the EG reflect the added value of AI integration rather than the inadequacy of traditional methods.

From a theoretical perspective, these findings align with Lev Vygotsky's (1978) (McLeod, 2024) sociocultural framework, particularly the concepts of mediation and the Zone of Proximal Development (ZPD). In this study, AI tools functioned as technological mediators that scaffolded students through an iterative process of drafting, receiving feedback, evaluating suggestions, and revising—mirroring the guided interaction described in sociocultural theory (Mekheimer, 2025; Mikaeili, 2026; Umar & Purwanto, 2025).The gradual improvements observed across writing tasks in the EG are consistent with the operation of the ZPD: students were supported in producing work beyond their current independent capabilities, and through repeated exposure to scaffolded processes, their independent competence progressively developed.

The perception questionnaire results further reinforce this interpretation. Most students reported that AI tools had a meaningful positive impact on their writing efficiency, grammatical accuracy, and organizational clarity dimensions that correspond to the areas where the largest quantitative gains were observed. This is consistent

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with the findings with (Fontanilla et al., 2025; Mahdi et al., 2025; Tran et al., 2025; Ya'u & Mohammed, 2025) The 30% of students who expressed concerns about a potential reduction in critical thinking (M = 2.90) highlight an issue that warrants serious consideration. This aligns with concept of cognitive offloading, referring to the risk that over-reliance on automated feedback may reduce the cognitive effort invested in higher-order thinking (Madera et al., 2025). However, the relatively low mean score for this concern suggests that the instructional design particularly the requirement for students to critically evaluate AI suggestions and maintain reflective journals may have effectively mitigated passive dependence. This underscores a broader pedagogical point: the benefits of AI-assisted writing instruction are not automatic, but depend heavily on the quality of the instructional framework in which the tools are embedded.

These findings carry important pedagogical implications for EFL writing instruction. First, the results support the deliberate integration of multiple complementary AI tools grammar checkers, paraphrasing tools, and generative AI within a single writing course, as this combination appears to produce broader and stronger learning gains than relying on a single tool alone. Second, explicit training in the critical use of AI is essential. Students should be taught not only how to use these tools, but also when to accept AI suggestions, when to question them, and how to reflect on their revision decisions. Third, the writing cycle implemented in this study drafting, receiving AI feedback, evaluating, revising, and submitting offers a replicable instructional model that can be adapted by other EFL programs. Finally, given the significant improvement in citation and referencing, there is a strong case for using AI tools to address academic integrity issues in Indonesian EFL contexts, provided that their use is guided by clear ethical frameworks.

Nevertheless, this study also has several limitations that should be acknowledged. These include methodological and contextual constraints such as the quasi-experimental design, the relatively short duration of the intervention, limited generalizability, potential bias due to the absence of teacher blinding, and the inability to isolate the specific contributions of individual AI tools. Furthermore, the lack of qualitative data limits a deeper understanding of the cognitive and metacognitive processes through which students engage with AI. Therefore, the findings should be interpreted with caution and considered as a foundation for more comprehensive future research.

Building on the analysis of individual writing dimensions, the overall effect size further confirms the substantial impact of AI-assisted writing instruction. The very large effect size observed in the overall score (Cohen's d = 2.00) indicates a cumulative improvement across multiple aspects of writing performance, reflecting the integrated nature of the intervention. This magnitude is consistent with the intensive and structured implementation of AI-supported writing activities, where continuous scaffolding, iterative feedback, and the combined use of multiple tools such as Grammarly, QuillBot, and ChatGPT likely reinforced learning outcomes. It is also possible that the relatively low initial proficiency of participants contributed to the magnitude of the observed gains. While these results demonstrate strong statistical and pedagogical significance, they should be interpreted in light of the study's methodological constraints, including sample size and contextual specificity. Therefore, the effect size should be understood as context-dependent and not generalized beyond similar instructional settings. Future research should further examine this phenomenon using larger samples and comparative designs across different AI-based writing interventions.

CONCLUSION

This study shows that AI-assisted writing instruction can significantly improve the academic writing skills of undergraduate EFL students. With regard to the first research question (RQ1), the results confirmed a significant effect of AI-assisted writing on students' academic writing skills (as reported in Tables 1 and 2). The experimental group performed better than the control group in all four areas: content and organization, grammar and mechanics, vocabulary and style, and citation and referencing. The results showed strong improvement, with large effect sizes based on Jacob Cohen and a higher N-Gain score (0.42) compared to the control group (0.20). With regard to the second research question (RQ2), the perception questionnaire data (Table 3) indicated that most students responded positively to AI writing tools, especially for improving writing efficiency, grammar, and confidence, although a few were concerned about overreliance.

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These findings suggest that AI tools can be useful in academic writing classes, especially when they are used with clear guidance and critical thinking activities. They can help students improve their writing, particularly in contexts where individual feedback is limited.

This study adds to existing research on AI in EFL writing and provides a practical model for teaching. Future studies should explore long-term effects, compare different AI tools, and examine how student characteristics influence learning outcomes.

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