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The Use of Artificial Intelligence (AI) Tools to Enhance University Students' Academic Writing Skills in English Education

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Abstract. *The rapid advancement of technology has transformed higher education, particularly in the domain of English academic writing, which requires complex cognitive, linguistic, and organizational skills. This study investigates the effectiveness of Artificial Intelligence (AI) tools in enhancing university students' academic writing performance, cognitive engagement, and learner autonomy. Using a quantitative one-group pretest–posttest design, 20 students participated in an AI-assisted writing intervention incorporating grammar checkers, paraphrasing aids, vocabulary enhancers, and automated feedback. Descriptive and non-parametric analyses, including the Wilcoxon Signed-Rank Test, were conducted to evaluate changes in writing performance, while students' perceptions were collected via questionnaires. The findings indicate significant improvements in accuracy, coherence, and overall writing quality, with reduced performance gaps among students. Learners reported positive experiences, emphasizing increased confidence, motivation, and autonomy in the writing process. Despite methodological limitations, the results highlight the pedagogical and cognitive benefits of AI integration, suggesting that AI tools can function as effective scaffolds for complex writing tasks. Implications for curriculum design and future research on long-term and diverse applications are also discussed.*

Keywords: *Artificial Intelligence, Academic Writing, Higher Education, Writing Performance, Learner Autonomy*

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INTRODUCTION

In the 21st century, rapid technological advancements are transforming the way people learn, prompting educators worldwide to adapt learning systems that are more interactive, personalized, and flexible (Kinshuk et al., 2016). These changes have had a significant impact on English education, particularly in the development of academic writing skills, which are increasingly recognized as essential components of global competence and academic achievement. Academic writing requires learners to organize ideas coherently, produce structured arguments, and adhere to formal conventions, making it a complex skill that demands continual practice and feedback (Mason & Atkin, 2021). For non-native English speakers, mastering these competencies presents additional challenges, including limited vocabulary, syntactic inaccuracies, and unfamiliarity with scholarly conventions, all of which can hinder the overall quality of their writing (Comelles & Laso, 2025).

To address these challenges, various instructional strategies have been developed, including collaborative learning, technology-enhanced language learning, and, more recently,

Artificial Intelligence (AI) applications (Dimitriadou & Lanitis, 2023). AI tools have emerged as a powerful innovation in educational technology, offering personalized guidance based on learners' writing patterns (Alam & Mohanty, 2023). Unlike traditional grammar checkers, modern AI-powered writing assistants can provide context-sensitive feedback, suggest vocabulary enhancements, and help students refine sentence structures and overall coherence (Thi et al., 2025). Such capabilities enable learners to engage in iterative drafting and revision, promoting both skill development and critical thinking (Lee et al., 2024).Moreover, AI tools support metacognitive awareness by allowing students to monitor their own progress and evaluate the appropriateness of suggested changes independently (Alazemi, 2024).

The integration of AI into writing instruction also has important pedagogical implications (Marzuki et al., 2023). AI facilitates immediate feedback and reduces the repetitive burden on educators, enabling teachers to focus on higher-level guidance, such as argumentation, style, and content development (Kim et al., 2022). By shifting the classroom dynamic toward learner-centered practices, AI tools enhance autonomy, motivation, and engagement (Kerimbayev et al., 2023). This approach aligns with constructivist principles, which emphasize reflection, exploration, and individualized learning pathways (Alamri et al., 2020). Consequently, AI-supported writing interventions have the potential to transform the traditional educational environment, fostering both linguistic competence and cognitive development (Engeness & Gamlem, 2025).

Despite these advantages, the implementation of AI in academic writing is not without challenges (Khalifa & Albadawy, 2024). Overreliance on automated feedback may reduce students' critical thinking and creative engagement, while inaccuracies or cultural biases in AI suggestions can occasionally mislead learners (Zhai et al., 2024). Ethical considerations, including authorship integrity, plagiarism, and data privacy, also require careful attention (Muthanna et al., 2024). Furthermore, disparities in access to technology and digital literacy can affect equitable learning opportunities (Tate & Warschauer, 2022). Addressing these issues necessitates structured guidance, reflective practice, and institutional policies that support the responsible and effective use of AI in education (Jin et al., 2025).

Given these opportunities and challenges, this study investigates the extent to which AI tools can enhance university students' academic writing skills in English education. The research focuses on both performance outcomes, such as accuracy, coherence, and analytical sophistication, and students' perceptions of AI-supported instruction. By examining the effectiveness, benefits, and limitations of AI integration, this study aims to contribute empirical evidence to the ongoing discourse on technology-mediated writing instruction. Ultimately, the findings are expected to inform educators and policymakers on strategies for implementing AI responsibly, ensuring that technology complements rather than replaces traditional pedagogical practices, while promoting ethical awareness and digital literacy among learners.

METHODS

This study employed a quantitative approach using a one-group pretest–posttest design to investigate the effectiveness of Artificial Intelligence (AI) tools in enhancing university students' academic writing skills. The research was conducted in three structured sessions. The first session was dedicated to the pre-test to assess the students' initial writing abilities. The second session consisted of an intensive AI-assisted writing intervention followed by a post-test to evaluate immediate performance gains. In the third session, students completed a Likert-scale questionnaire to provide feedback on their experiences and perceptions of the AI tools. A single intact class consisting of 20 students was selected through purposive sampling based on their enrollment in an academic writing course (Abubakar Garba et al., 2023). While the absence of a control group is a recognized limitation of this exploratory design, the use of multiple independent raters and a standardized assessment framework was implemented to strengthen the study's internal validity and mitigate potential bias.

Primary data were collected from students' writing performance on both the pretest and posttest. To ensure the rigor and objectivity of the assessment, the students' essays were evaluated using a standardized writing rubric developed by H. Douglas Brown (2004), which covers five core dimensions: content, organization, vocabulary, syntax, and mechanics. The scoring process involved three independent raters: the primary researcher and two experienced English education lecturers. To maintain high reliability, an inter-rater consistency check was performed, and any scoring discrepancies were resolved through a consensus-based discussion.

The instructional intervention integrated specific Generative AI tools at different stages of the writing process. Three primary platforms were utilized: ChatGPT (OpenAI), Gemini (Google), and Perplexity AI. Specifically, ChatGPT was employed during the pre-writing phase for brainstorming and structural outlining. Perplexity AI was used to assist students in finding credible academic references and verifying in-text citations. Finally, Gemini was integrated during the drafting and editing phases to refine linguistic cohesion and grammatical accuracy. This structured approach ensured that AI served as a cognitive scaffold for writing development.

Supporting data were also obtained through a perception questionnaire administered after the treatment to gather students' views on the use of these AI tools (Teng, 2024). Data analysis followed several steps. First, Kolmogorov–Smirnov and Shapiro–Wilk tests were conducted, indicating that the scores did not follow a normal distribution, necessitating the use of non-parametric procedures (Farra et al., 2024). Consequently, the Wilcoxon Signed-Rank Test was employed to examine improvements in students' performance. Furthermore, to evaluate the practical magnitude of the intervention, the effect size (r) was calculated and interpreted based on Cohen's guidelines. Descriptive statistics, including means and standard deviations, were also used to illustrate the distribution of improvement, while questionnaire responses were analyzed using percentage analysis (Grájeda et al., 2023).

RESULTS AND DISCUSSION

This section presents the empirical results derived from the analysis of students' academic writing performance before and after the implementation of Generative AI–assisted feedback. The findings are systematically organized to address the research question concerning the extent to which AI-supported feedback contributes to measurable improvements in academic writing outcomes. The analytical procedures include descriptive statistical observations, normality testing, and non-parametric inferential analysis using the Wilcoxon Signed-Rank Test due to the non-normal distribution of the dataset.

The results reveal a notable progression in students' writing performance following the intervention. The descriptive statistics indicate an upward shift in the mean score of the post-test compared to the pre-test, accompanied by reduced score dispersion. These initial findings provide an early indication that the integration of Generative AI tools facilitated improvements in students' accuracy, organization, and clarity in academic writing. Subsequent statistical tests further substantiate the presence of a significant difference between the two measurements.

These findings are consistent with existing literature asserting that AI-driven writing support enhances students' revision quality, linguistic accuracy, and overall writing competence. Nonetheless, the present study extends previous research by providing empirical evidence specific to English education students within an Indonesian higher-education context. The results demonstrate that Generative AI tools function not merely as corrective mechanisms but also as instructional aids that promote deeper engagement with academic writing conventions. Detailed explanations of each statistical result are presented in the following subsections. The results of the pre-test and post-test were analyzed to determine the improvement in students' academic writing performance after the implementation of AI tools. Table 1 shows the pre-test and post-test scores of students' writing.

Table 1. Student' pre-test and post-test writing scores

Student's	Pre-test	Post-test
Abib al-absin	51	85
Ayu Surya Ningsih	83	88
Elia Nirmantari	56	85
Endang Trirezeki	70	85
Hemiyati	74	86
Junita Ulhusna	70	80
Nurhaedatul	80	87
Nayla Lutfia	81	89
Nafah Hilaliati	52	75
Putri Hindun A shahab	86	87
Rayyani	51	85
Risnawati	77	86
Siti Nurfiati	59	76
Zikrina Hidayati	65	93
Zahwa Laila Fazia	83	90
Rizka Saputri	49	82
Adriansyah	52	59
Yeni Khairunnisa	50	76
Nabila	42	65
M. Khairul Amrian	47	75

The pre-test and post-test were administered to measure students' academic writing performance before and after the implementation of Generative AI–assisted feedback. The pre-test was given prior to the intervention to identify students' initial writing proficiency, while the post-test was conducted after the treatment to evaluate the degree of improvement achieved. The descriptive statistical results of both assessments, including the minimum, maximum, mean, standard deviation, and variance, are presented in Table 2.

Tabel.2 Descriptive Statistic

Statistic Descriftive	N	Minimum	Maximum	Mean	Standart Daviation	Variance
Pre-Test	20	42	86	63.90	14.513	210.621
Post-Test	20	59	93	81.70	8.517	72.537

Tabel 2. provides an overview of students' academic performance in English writing prior to the integration of instructional interventions. The pre-test scores obtained from 20 students ranged from 42 to 86, with a mean of 63.90 and a standard deviation of 14.513. These results indicate a wide variation in the students' initial writing abilities, suggesting that while some students demonstrated moderate competence, others performed significantly below the expected academic standard. The relatively high standard deviation reflects a substantial performance gap among students, highlighting inconsistencies in their ability to organize ideas, apply appropriate vocabulary, and construct grammatically correct sentences before the intervention.

In contrast, the post-test scores show a significant improvement in students' writing performance after the learning intervention. Scores ranged from 59 to 93, with a mean of 81.70 and a standard deviation of 8.517. The notable increase in the mean score, along with the reduction in score dispersion, indicates that the intervention effectively enhanced overall writing skills while also promoting more consistent performance across the class. The decrease in variability suggests that weaker students were able to improve substantially, narrowing the performance gap and achieving a more uniform level of academic writing proficiency. A normality

test was performed to assess whether the students' pre-test and post-test scores followed a distribution suitable for parametric analysis.

Tabel 3. Test of Normality

Test	Statistic	df	Sig.	Description
Kolmgorov- Smirnov	0.194	20	0.047	Abnormal
Shapiro-Wilk	0.903	20	0.026	Abnormal

Table 3. presenting the results of the normality test for the pre-test scores indicates that the distribution of students' academic writing performance prior to the intervention did not meet the assumption of normality. The Kolmogorov–Smirnov test yielded a significance value of 0.047, and the Shapiro–Wilk test produced a significance value of 0.026, both of which are below the conventional threshold of 0.05. These results demonstrate that the pre-test data deviate significantly from a normal distribution, suggesting that students' initial writing abilities varied considerably and were not centered around an expected mean.

The non-normality observed reflects substantial disparities in students' foundational writing skills. Some students exhibited moderate to high proficiency, whereas others performed well below the anticipated academic standard. This wide variation indicates inconsistencies in critical writing competencies, including idea organization, vocabulary selection, and grammatical accuracy, at the beginning of the course. Such a condition represents genuine differences in baseline performance rather than random fluctuation.

Consequently, the characteristics of the data necessitate the use of analytical methods suitable for non-normally distributed scores. These findings highlight that any improvements measured after the intervention must account for the uneven starting points of the students, ensuring that the analysis accurately reflects the effectiveness of the applied instructional strategy in enhancing academic writing performance across the entire class.

Tabel 4. Test of Normality

Test	Statistic	df	Sig.	Description
Kolmogorov-Smirnov	0.251	20	0.002	Abnormal
Shapiro- Wilk	0.871	20	0.012	Abnormal

Table 4 showing the results of the normality test for the post-test scores provides clear evidence regarding the distributional characteristics of the data. The Kolmogorov–Smirnov test yielded a significance value of 0.002, and the Shapiro–Wilk test produced a significance value of 0.012, both of which are below the standard threshold of 0.05, indicating that the post-test scores do not conform to a normal distribution. These results suggest that while the students' writing performance improved after the intervention, the distribution of scores remained uneven across the class.

The persistence of non-normality reflects continued variability in students' writing abilities. Although many students achieved higher performance levels compared to the pre-test, some participants still lagged behind, indicating that improvements in idea organization, vocabulary use, and sentence construction did not occur uniformly. Individual differences in engagement, prior writing proficiency, and familiarity with Generative AI tools likely contributed to these variations.

These findings highlight that-analytical methods appropriate for non-normally distributed data are required to accurately interpret the post-test results. Moreover, the results emphasize that while the intervention effectively enhanced overall academic writing performance, the extent of improvement varied among students. This underscores the reality that learning outcomes are influenced by diverse abilities and initial skill levels, reinforcing the importance of targeted strategies to support all learners and achieve more consistent outcomes across the class. Since the data did not meet the assumption of normality, the Wilcoxon Signed-

Rank Test was used to examine whether there was a significant difference between the students' pre-test and post-test scores.

Tabel 5. Wilcoxon Signed-Rank Test

Statistic Test	Value	Description
Z	-3.922	Based on Negative Rank
Sig. (2-tailed)	<.001	There is a significant difference

Table 5 displays the comparison of students' pre-test and post-test scores using the Wilcoxon Signed-Rank Test. The test produced a Z value of -3.922 with a significance level of $p < .001$ (2-tailed). This indicates a statistically significant improvement in students' academic writing performance following the intervention. Furthermore, the analysis revealed a large effect size ($r = 0.62$), which confirms that the intervention had a substantial and meaningful practical impact on students' writing abilities, beyond just statistical significance. The negative Z value reflects the ranking procedure used in the test, showing that post-test scores were consistently higher than pre-test scores.

The significance value far below 0.05 confirms that the improvement in students' scores is unlikely to be due to chance. These results suggest that students became more proficient at organizing ideas, selecting appropriate vocabulary, and constructing grammatically correct sentences after receiving guided support through AI tools. These findings provide strong evidence that the intervention had a meaningful impact across the class. The consistent increase in scores, coupled with the large effect size, indicates that most students benefited significantly from the instructional strategy, supporting its effectiveness in improving academic writing skills in a structured and measurable way.

Table 6. Questionnaire result

NO	Indicators and Items	SA (%)	A (%)
A	Perceived Usefulness & efficiency		
1	AI tools help in generating and organizing ideas.	25%	35%
2	Using AI (ChatGPT/Gemini) speeds up the drafting process.	25%	40%
3	Perplexity AI assists in finding credible references.	20%	45%
B	Writing Quality & Accuracy		
4	AI tools help in correcting grammar and syntax errors.	30%	30%
5	AI assistance improves the overall coherence of the essay.	25%	35%
6	Students feel their vocabulary usage becomes more varied.	20%	40%
C	Confidence & Learning Autonomy		
7	Students feel more confident in writing academic papers.	25%	30%
8	Using AI tools reduces writing anxiety and "writer's block."	30%	35%
9	AI acts as a supportive scaffold for independent learning.	25%	40%

Table 6 presents the distribution of students' perceptions regarding the integration of ChatGPT, Gemini, and Perplexity in their academic writing course. Overall, the data reveals a predominantly positive response. In the category of Perceived Usefulness and Efficiency, approximately 65% of students agreed that these AI tools significantly accelerated their drafting process. Specifically, participants noted that Perplexity AI was highly effective in assisting them

to find and verify credible academic references, which resolved one of the most challenging aspects of academic writing.

In terms of Writing Quality and Accuracy, 60% of the respondents reported that AI assistance particularly from Gemini and ChatGPT helped them identify grammatical errors and enhance the overall coherence of their essays. This perception is consistent with the significant improvement observed in the post-test scores, where linguistic precision and structural organization were markedly higher than in the pre-test results.

Furthermore, the data on Confidence and Learning Autonomy provides insight into the psychological impact of the intervention. About 65% of students felt that the AI tools reduced their writing anxiety and helped them overcome 'writer's block.' This indicates that these tools did not function merely as automated editors, but rather as a cognitive scaffold that provided the necessary support for students to engage more confidently with complex writing tasks. The synergy between these positive perceptions and the large effect size (r = 0.62) found in the statistical analysis suggests that the integrated use of ChatGPT, Gemini, and Perplexity is an effective pedagogical approach for enhancing both the writing performance and the self-efficacy of university students.

Cognitive Impact

The findings of this study demonstrate that AI-supported tools can significantly facilitate students' management of complex academic writing tasks (Larios Soldevilla et al., 2025). The large effect size (r = 0.62) observed in this study provides empirical evidence that the intervention had a substantial practical impact on students' proficiency, specifically by acting as a cognitive scaffold. Producing coherent academic texts in a second language requires simultaneous attention to idea generation, lexical choice, grammatical accuracy, and overall organization (Abad-Castro et al., 2025). By providing immediate guidance on sentence structures, vocabulary alternatives, and paragraph organization, the AI system reduced cognitive load and allowed students to focus on higher-order writing processes, such as argument development and coherence (Khan et al., 2025). Referring to the improvements observed in the Findings section, it is evident that weaker learners benefited from this scaffolding alongside stronger students, creating more uniform performance across the group (Hurwitz & Macaruso, 2021). Over repeated cycles of drafting and revising, learners began to internalize patterns of academic discourse, demonstrating skill acquisition that extended beyond surface-level accuracy (Chenekew Goshu et al., 2025). The cognitive support offered by AI thus contributed to enhanced self-regulation, reflection, and more efficient allocation of mental resources. In this way, the intervention acted as a structured scaffold, gradually transferring responsibility to the learners while fostering deeper engagement with academic writing. The results highlight the potential of AI to support equitable learning outcomes by addressing individual differences in initial proficiency levels.

Pedagogical Implications

The integration of ChatGPT, Gemini, and Perplexity brought substantial pedagogical changes to the classroom dynamic (Dimitriadou & Lanitis, 2023). Prior to the intervention, feedback was largely teacher-centered, delayed, and focused on final drafts rather than the iterative process of writing (Ekizoğlu & Demir, 2025). With AI support, students were able to receive immediate guidance, experiment with alternative formulations, and revise drafts multiple times before submission (Awidi, 2024). Perplexity AI, in particular, helped students verify credible sources, which enhanced their research autonomy. Teachers transitioned into the role of facilitators, guiding students to interpret AI suggestions, reflect on choices, and make informed decisions regarding their writing (Daher, 2025). This shift encouraged learner autonomy and emphasized writing as a recursive process involving planning, drafting, editing, and revising (Wu et al., 2020). The new pedagogical approach fostered active engagement, enabling students to take responsibility for their learning while maintaining collaboration with instructors (Heilporn et al., 2021). By complementing rather than replacing teacher input, AI tools contributed to a richer, more interactive educational environment (Bower et al., 2024). The observed

improvements reported in the Findings section suggest that such pedagogical transformations enhanced overall learning outcomes while supporting students' development of transferable academic skills. This demonstrates the potential for AI to act as a meaningful partner in process-oriented writing instruction.

Students' Perceptions

Learner perceptions offer further insight into the intervention's effectiveness (Shen & Chong, 2023). The Likert-scale results presented in the Findings section indicate that most students perceived the AI tools as supportive in generating ideas, organizing paragraphs, and increasing confidence in their writing (Escalante et al., 2023). This positive perception aligns with the statistical findings, suggesting that the reduction in writing anxiety contributed to the high effectiveness of the tools (r = 0.62). Some students expressed uncertainty or required additional guidance, emphasizing the importance of orientation and structured support when introducing technology into learning (Yusuf et al., 2024). Positive perceptions can reinforce engagement, leading to more frequent practice and iterative refinement of writing skills, while negative or uncertain perceptions may limit the benefits of AI integration (Lin & Chen, 2024). These results highlight the critical role of learner attitudes in determining the efficacy of technology-assisted interventions (Jedi-Sari-Biglar & Liman-Kaban, 2023). By fostering positive experiences and motivation, AI-supported writing can encourage sustained engagement and promote the internalization of academic writing strategies (Xu et al., 2025). Understanding and addressing students' perceptions is therefore essential for maximizing both skill development and learner satisfaction.

Alignment with Previous Research

The study's findings align with broader research on technology-enhanced learning and writing instruction (Zou et al., 2023). AI-supported interventions have been shown to improve linguistic accuracy, text organization, and learner autonomy, while also fostering engagement and motivation (Namaziandost, 2025). However, this study extends prior research by illustrating how AI can reduce cognitive load, support weaker learners, and promote more consistent achievement across a cohort. Unlike studies focused solely on surface-level improvements, the current investigation emphasizes both cognitive and pedagogical dimensions, revealing a holistic impact of AI integration in the writing classroom (Gao et al., 2025). By linking findings from the current research to broader theoretical perspectives, the discussion underscores the multifaceted role of AI as a pedagogical and cognitive scaffold (Dai, 2025). The results suggest that thoughtfully implemented AI interventions can support equitable learning and contribute to the development of transferable academic writing skills.

Limitations

Despite positive outcomes, several methodological limitations must be acknowledged (Van Calster et al., 2021). The study employed a one-group pretest-posttest design without a control group and relatively small sample size (N=20), limiting the ability to attribute improvements exclusively to the AI intervention (Chang et al., 2022). However, the large effect size (r = 0.62) suggests that the findings are robust and provide a meaningful foundation for this exploratory study. Additionally, the short duration of the study restricts conclusions regarding long-term retention of writing skills (Smith et al., 2021). Individual variability in responses suggests that some students may benefit more than others, highlighting the need for careful guidance and scaffolded support (van der Graaf et al., 2023). The study also notes that some learners may experience uncertainty or overreliance on AI suggestions, which underscores the importance of reflective practice and teacher facilitation (Avci et al., 2025). Recognizing these limitations provides a balanced interpretation of the findings and informs the design of future research (Espartinez, 2024). By addressing these constraints, subsequent studies can more definitively evaluate the effectiveness and sustainability of AI-supported interventions in academic writing instruction.

Implications for Future Research

Future investigations should address the identified limitations by incorporating control groups, extending the duration of interventions, and employing longitudinal designs to assess skill retention (Alharbi et al., 2024). Qualitative analyses of student drafts, revision histories, and reflective reports would provide deeper insight into cognitive and metacognitive processes involved in AI-assisted writing (Wang et al., 2024). Research could also explore the application of AI tools across different proficiency levels, writing genres, and educational contexts, further elucidating factors that influence efficacy (Gayed et al., 2022). These efforts would contribute to evidence-based frameworks for integrating AI into higher education writing curricula and enhance understanding of how technology can support complex learning tasks (Salido et al., 2025). Expanding research in these areas would strengthen theoretical models and provide practical guidance for the effective implementation of AI-supported instruction.

AI-supported writing interventions provide substantial cognitive, pedagogical, and motivational benefits for university students (Yeung, 2025). By scaffolding complex tasks, promoting learner autonomy, and enabling iterative revision, AI tools enhance both the quality and consistency of academic writing performance (Siu et al., 2025). While methodological constraints must be acknowledged, the combination of observed improvements, reduced variability, and largely positive student perceptions indicates that AI can serve as an effective pedagogical partner in higher education contexts. Thoughtful integration of AI into writing curricula has the potential to foster equitable learning, support skill development, and encourage sustained engagement in academic writing processes, providing a promising direction for future educational practice and research.

CONCLUSION

This study demonstrates that the integration of AI-supported tools in university-level academic writing can substantially enhance students' performance, cognitive engagement, and learning autonomy. The intervention facilitated more efficient management of complex writing tasks by providing scaffolding for idea generation, vocabulary selection, sentence construction, and paragraph organization, allowing learners to focus on higher-order writing processes such as coherence, argumentation, and reflective revision. Beyond improving overall performance, the approach contributed to more equitable outcomes across the cohort, supporting weaker learners alongside stronger peers. Pedagogically, AI transformed classroom dynamics by complementing teacher guidance, fostering learner-centered practices, and promoting iterative engagement with the writing process. These findings indicate that thoughtfully implemented AI tools can serve as powerful cognitive and pedagogical aids, advancing the field of educational technology by demonstrating how digital scaffolding can support complex academic tasks in higher education contexts. Furthermore, the study provides practical implications for curriculum design, suggesting that integrating AI can enhance student autonomy, engagement, and the quality of academic outputs.

SUGGESTION

Future research should explore long-term effects, diverse proficiency levels, and applications across different writing genres, as well as qualitative insights into learners' interactions with AI to optimize instructional strategies and ensure sustained skill development. Overall, this work highlights the potential of AI-supported writing interventions to advance pedagogical practices, improve learning outcomes, and provide a foundation for further exploration into technology-enhanced education.

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REFERENCES

Abad-Castro, R. I., Martínez-García, C., & Suárez-Coalla, P. (2025). Impact of digital tools for the development of written expression in German as a foreign language in young Spanish speaking adults. *Reading and Writing*. https://doi.org/10.1007/s11145-025-10692-2

Abubakar Garba, M., Bin Hassan, A. R., & Abdul Jabar, M. A. (2023). Functions of collocations in the prevention of linguistic errors among Arabic learners as a foreign language. *Cogent Social Sciences*, *9*(2). https://doi.org/10.1080/23311886.2023.2260608

Alam, A., & Mohanty, A. (2023). Educational technology: Exploring the convergence of technology and pedagogy through mobility, interactivity, AI, and learning tools. *Cogent Engineering*, *10*(2). https://doi.org/10.1080/23311916.2023.2283282

Alamri, H., Lowell, V., Watson, W., & Watson, S. L. (2020). Using personalized learning as an instructional approach to motivate learners in online higher education: Learner self-determination and intrinsic motivation. *Journal of Research on Technology in Education*, *52*(3), 322–352. https://doi.org/10.1080/15391523.2020.1728449

Alazemi, A. F. T. (2024). Formative assessment in artificial integrated instruction: delving into the effects on reading comprehension progress, online academic enjoyment, personal best goals, and academic mindfulness. *Language Testing in Asia*, *14*(1). https://doi.org/10.1186/s40468-024-00319-8

Alharbi, A., Nurfianti, A., Mullen, R. F., McClure, J. D., & Miller, W. H. (2024). The effectiveness of simulation-based learning (SBL) on students' knowledge and skills in nursing programs: a systematic review. *BMC Medical Education*, *24*(1). https://doi.org/10.1186/s12909-024-06080-z

Avci, H., Lunn, S. J., & Hazari, Z. (2025). Exploring STEM educators' perspectives on the integration of AI-enabled technologies in teaching and learning. *Computers and Education Open*, *9*(October), 100304. https://doi.org/10.1016/j.caeo.2025.100304

Awidi, I. T. (2024). Comparing expert tutor evaluation of reflective essays with marking by generative artificial intelligence (AI) tool. *Computers and Education: Artificial Intelligence*, *6*(February), 100226. https://doi.org/10.1016/j.caeai.2024.100226

Bower, M., Torrington, J., Lai, J. W. M., Petocz, P., & Alfano, M. (2024). How should we change teaching and assessment in response to increasingly powerful generative Artificial Intelligence? Outcomes of the ChatGPT teacher survey. In *Education and Information Technologies* (Vol. 29, Issue 12). Springer US. https://doi.org/10.1007/s10639-023-12405-0

Chang, S. J., Lee, K. eun, Yang, E., & Ryu, H. (2022). Evaluating a theory-based intervention for improving eHealth literacy in older adults: a single group, pretest–posttest design. *BMC Geriatrics*, *22*(1), 1–9. https://doi.org/10.1186/s12877-022-03545-y

Chenekew Goshu, K., Tesfay Gebremariam, H., Getachew Atekelkel, Z., & Alem Siawk, Y. (2025). Honing writing acuity: The synergistic role of teacher-student conferences and student self-reflection in writing skills. *Social Sciences and Humanities Open*, *12*(August), 102020. https://doi.org/10.1016/j.ssaho.2025.102020

Comelles, E., & Laso, N. J. (2025). The impact of MT as a writing tool on EFL academic writing: A qualitative linguistic analysis. *Journal of Second Language Writing*, *69*(February 2024), 101231. https://doi.org/10.1016/j.jslw.2025.101231

Daher, R. (2025). Integrating AI literacy into teacher education: a critical perspective paper. *Discover Artificial Intelligence*, *5*(1). https://doi.org/10.1007/s44163-025-00475-7

Dai, Y. (2025). Integrating unplugged and plugged activities for holistic AI education: An embodied constructionist pedagogical approach. *Education and Information Technologies*, *30*(5), 6741–6764. https://doi.org/10.1007/s10639-024-13043-w

Dimitriadou, E., & Lanitis, A. (2023). A critical evaluation, challenges, and future perspectives of using artificial intelligence and emerging technologies in smart classrooms. *Smart Learning Environments*, *10*(1). https://doi.org/10.1186/s40561-023-00231-3

Ekizoğlu, M., & Demir, A. N. (2025). The role of AI assisted writing feedback in developing secondary students writing skills. *Discover Education*, *4*(1), 1–16. https://doi.org/10.1007/s44217-025-00919-3

Engeness, I., & Gamlem, S. M. (2025). Exploring AI-Driven Feedback as a Cultural Tool: A Cultural-Historical Perspective on Design of AI Environments to Support Students' Writing Process. *Integrative Psychological and Behavioral Science*, *59*(1), 1–23. https://doi.org/10.1007/s12124-025-09894-8

Escalante, J., Pack, A., & Barrett, A. (2023). AI-generated feedback on writing: insights into efficacy and ENL student preference. *International Journal of Educational Technology in Higher Education*, *20*(1). https://doi.org/10.1186/s41239-023-00425-2

Espartinez, A. S. (2024). Exploring student and teacher perceptions of ChatGPT use in higher education: A Q-Methodology study. *Computers and Education: Artificial Intelligence*, *7*(February), 100264. https://doi.org/10.1016/j.caeai.2024.100264

Farra, N. K. Al, Belbase, S., Tairab, H., Qablan, A., Opoku, M. P., & Safi, S. K. (2024). Impact of using virtual and concrete manipulatives on students' learning of fractions. *Cogent Education*, *11*(1). https://doi.org/10.1080/2331186X.2024.2379712

Gao, J., Zhang, J., & Li, Y. (2025). Do AI chatbot-integrated writing tasks influence writing self-efficacy and critical thinking ability? An exploratory study. *Computers and Education: Artificial Intelligence*, *9*(August), 100472. https://doi.org/10.1016/j.caeai.2025.100472

Gayed, J. M., Carlon, M. K. J., Oriola, A. M., & Cross, J. S. (2022). Exploring an AI-based writing Assistant's impact on English language learners. *Computers and Education: Artificial Intelligence*, *3*(January), 100055. https://doi.org/10.1016/j.caeai.2022.100055

Grájeda, A., Burgos, J., Córdova, P., & Sanjinés, A. (2023). Assessing student-perceived impact of using artificial intelligence tools: Construction of a synthetic index of application in higher education. *Cogent Education*, *11*(1). https://doi.org/10.1080/2331186X.2023.2287917

Heilporn, G., Lakhal, S., & Bélisle, M. (2021). An examination of teachers' strategies to foster student engagement in blended learning in higher education. *International Journal of Educational Technology in Higher Education*, *18*(1). https://doi.org/10.1186/s41239-021-00260-3

Hurwitz, L. B., & Macaruso, P. (2021). Supporting struggling middle school readers: Impact of the Lexia® PowerUp literacy® program. *Journal of Applied Developmental Psychology*, *77*(September), 101329. https://doi.org/10.1016/j.appdev.2021.101329

Jedi-Sari-Biglar, L., & Liman-Kaban, A. (2023). Exploring the effect of mobile-assisted task-based learning on vocabulary achievement and student attitude. *Smart Learning Environments*, *10*(1). https://doi.org/10.1186/s40561-023-00270-w

Jin, Y., Yan, L., Echeverria, V., Gašević, D., & Martinez-Maldonado, R. (2025). Generative AI in higher education: A global perspective of institutional adoption policies and guidelines. *Computers and Education: Artificial Intelligence*, *8*(December 2024), 100348. https://doi.org/10.1016/j.caeai.2024.100348

Kerimbayev, N., Umirzakova, Z., Shadiev, R., & Jotsov, V. (2023). A student-centered approach using modern technologies in distance learning: a systematic review of the literature. *Smart Learning Environments*, *10*(1). https://doi.org/10.1186/s40561-023-00280-8

Khalifa, M., & Albadawy, M. (2024). Using artificial intelligence in academic writing and research: An essential productivity tool. *Computer Methods and Programs in Biomedicine Update*, *5*(March), 100145. https://doi.org/10.1016/j.cmpbup.2024.100145

Khan, R., Qamar, M. T., Ansari, M. S., & Yasmeen, J. (2025). Enhancing or impairing? Exploring Indian EFL learners' academic writing narratives with ChatGPT. *Cogent Education*, *12*(1). https://doi.org/10.1080/2331186X.2025.2514329

Kim, J., Lee, H., & Cho, Y. H. (2022). Learning design to support student-AI collaboration: perspectives of leading teachers for AI in education. In *Education and Information Technologies* (Vol. 27, Issue 5). Springer US. https://doi.org/10.1007/s10639-021-10831-6

Kinshuk, Chen, N. S., Cheng, I. L., & Chew, S. W. (2016). Evolution Is not enough: Revolutionizing Current Learning Environments to Smart Learning Environments. *International Journal of Artificial Intelligence in Education*, *26*(2), 561–581. https://doi.org/10.1007/s40593-016-0108-x

Larios Soldevilla, O. A., Mendoza Ibarra, V., Urdanegui Sibina, R., Zilberman, J., Lizola-Margolis, P. E., Flores Peraltilla, A. V., Herz Ghersi, J., Valencia Brenis, M., & Aviles Valdez, J. R. (2025). Adoption of AI tools and their impact on the academic research output of business school students. *Cogent Education*, *12*(1). https://doi.org/10.1080/2331186X.2025.2556892

Lee, H. Y., Chen, P. H., Wang, W. S., Huang, Y. M., & Wu, T. T. (2024). Empowering ChatGPT with guidance mechanism in blended learning: effect of self-regulated learning, higher-order thinking skills, and knowledge construction. *International Journal of Educational Technology in Higher Education*, *21*(1). https://doi.org/10.1186/s41239-024-00447-4

Lin, H., & Chen, Q. (2024). Artificial intelligence (AI) -integrated educational applications and college students' creativity and academic emotions: students and teachers' perceptions and attitudes. *BMC Psychology*, *12*(1). https://doi.org/10.1186/s40359-024-01979-0

Marzuki, Widiati, U., Rusdin, D., Darwin, & Indrawati, I. (2023). The impact of AI writing tools on the content and organization of students' writing: EFL teachers' perspective. *Cogent Education*, *10*(2). https://doi.org/10.1080/2331186X.2023.2236469

Mason, S., & Atkin, C. (2021). Capturing the struggle: adult learners and academic writing. *Journal of Further and Higher Education*, *45*(8), 1048–1060. https://doi.org/10.1080/0309877X.2020.1851663

Muthanna, A., Chaaban, Y., & Qadhi, S. (2024). A model of the interrelationship between research ethics and research integrity. *International Journal of Qualitative Studies on Health and Well-Being*, *19*(1). https://doi.org/10.1080/17482631.2023.2295151

Namaziandost, E. (2025). Integrating flipped learning in AI-enhanced language learning: Mapping the effects on metacognitive awareness, writing development, and foreign language learning boredom. *Computers and Education: Artificial Intelligence*, *9*(December 2024), 100446. https://doi.org/10.1016/j.caeai.2025.100446

Salido, A., Syarif, I., Sitepu, M. S., Suparjan, Wana, P. R., Taufika, R., & Melisa, R. (2025). Integrating critical thinking and artificial intelligence in higher education: A bibliometric and systematic review of skills and strategies. *Social Sciences and Humanities Open*, *12*(August). https://doi.org/10.1016/j.ssaho.2025.101924

Shen, R., & Chong, S. W. (2023). Learner engagement with written corrective feedback in ESL and EFL contexts: a qualitative research synthesis using a perception-based framework.

Assessment and Evaluation in Higher Education, *48*(3), 276–290. https://doi.org/10.1080/02602938.2022.2072468

Siu, K. W. M., Zou, J., Jiang, Y., Yang, Z., Zhang, K., & Zhao, T. (2025). Dynamic scaffolding: exploring the role of artificial intelligence in urban design education. *Frontiers of Urban and Rural Planning*, *3*(1). https://doi.org/10.1007/s44243-025-00060-7

Smith, R., Snow, P., Serry, T., & Hammond, L. (2021). The Role of Background Knowledge in Reading Comprehension: A Critical Review. *Reading Psychology*, *42*(3), 214–240. https://doi.org/10.1080/02702711.2021.1888348

Tate, T., & Warschauer, M. (2022). Equity in online learning. *Educational Psychologist*, *57*(3), 192–206. https://doi.org/10.1080/00461520.2022.2062597

Teng, M. F. (2024). "ChatGPT is the companion, not enemies": EFL learners' perceptions and experiences in using ChatGPT for feedback in writing. *Computers and Education: Artificial Intelligence*, *7*(July). https://doi.org/10.1016/j.caeai.2024.100270

Thi, X. H. N., Thien, H. V. H., Vuong, K. N., & Nguyen, T. T. (2025). Enhancing writing skills through AI-powered tools: perceived benefits and challenges among Vietnamese EFL students. *Discover Education*, *4*(1). https://doi.org/10.1007/s44217-025-00905-9

Van Calster, B., Wynants, L., Riley, R. D., van Smeden, M., & Collins, G. S. (2021). Methodology over metrics: current scientific standards are a disservice to patients and society. *Journal of Clinical Epidemiology*, *138*, 219–226. https://doi.org/10.1016/j.jclinepi.2021.05.018

van der Graaf, J., Raković, M., Fan, Y., Lim, L., Singh, S., Bannert, M., Gašević, D., & Molenaar, I. (2023). How to design and evaluate personalized scaffolds for self-regulated learning. *Metacognition and Learning*, *18*(3), 783–810. https://doi.org/10.1007/s11409-023-09361-y

Wang, C., Li, Z., & Bonk, C. (2024). Understanding self-directed learning in AI-Assisted writing: A mixed methods study of postsecondary learners. *Computers and Education: Artificial Intelligence*, *6*(June), 100247. https://doi.org/10.1016/j.caeai.2024.100247

Wu, W. C. V., Yang, J. C., Scott Chen Hsieh, J., & Yamamoto, T. (2020). Free from demotivation in EFL writing: the use of online flipped writing instruction. *Computer Assisted Language Learning*, *33*(4), 353–387. https://doi.org/10.1080/09588221.2019.1567556

Xu, S., Su, Y., & Liu, K. (2025). Investigating student engagement with AI-driven feedback in translation revision: A mixed-methods study. *Education and Information Technologies*, *30*(12), 16969–16995. https://doi.org/10.1007/s10639-025-13457-0

Yeung, S. (2025). University students' engagement with generative AI-supported automated writing evaluation (AWE) feedback. *Journal of Second Language Writing*, *68*(June 2024), 101203. https://doi.org/10.1016/j.jslw.2025.101203

Yusuf, A., Pervin, N., & Román-González, M. (2024). Generative AI and the future of higher education: a threat to academic integrity or reformation? Evidence from multicultural perspectives. *International Journal of Educational Technology in Higher Education*, *21*(1). https://doi.org/10.1186/s41239-024-00453-6

Zhai, C., Wibowo, S., & Li, L. D. (2024). The effects of over-reliance on AI dialogue systems on students' cognitive abilities: a systematic review. *Smart Learning Environments*, *11*(1). https://doi.org/10.1186/s40561-024-00316-7

Zou, D., Xie, H., & Wang, F. L. (2023). Effects of technology enhanced peer, teacher and self-feedback on students' collaborative writing, critical thinking tendency and engagement in learning. *Journal of Computing in Higher Education*, *35*(1), 166–185. https://doi.org/10.1007/s12528-022-09337-y