The Effects of AI-Supported Metacognitive Strategy Instruction on the Writing Performance of Non-English Majors

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ABSTRACT

Since the rise of Artificial Intelligence (AI), its role in language teaching has sparked ongoing debate. This research investigates whether AI-supported metacognitive strategy instruction can enhance students' writing performance, given that the connection between AI use and metacognitive strategies has been little discussed and that non–English majors have been well in research on AI in writing classes. The study employed a quasi-experimental design involving 79 students: the experimental group received instruction in an AI-supported metacognitive strategy using ChatGPT, and the control group was taught using a teacher-led approach. Both groups took a pre-test and a post-test to assess their writing performance, and the results were analyzed using Paired- and independent-samples t-tests. Semi-structured interviews with 10 participants were conducted concurrently to analyze students' experiences with AI-assisted learning. The final findings reflect a positive influence of AI on students' writing performance, while also highlighting some concerns about AI's reliability and potential misuse.

Keywords: Artificial Intelligence, ChatGPT, AI-supported metacognitive strategy instruction, writing performance, non-English majors

Introduction

Being a productive skill by nature, writing – though important – seems to be highly challenging for students, particularly non-English majors who often have limited linguistic competence and self-regulation skills. Involving more than just skill, writing is a metacognitive process that demands aesthetic appeal, legibility, fluency, and emotional engagement (Zimmerman & Kitsantas, 2007). Therefore, metacognitive strategy instruction has proved to improve both students' metacognitive awareness and their writing performance (Cer, 2019; Escorcia & Gimenes, 2020; Xu & Zhang, 2023)

Given the rapid advancement of technology, it is now possible to provide explicit instruction on metacognitive strategies, augmented by AI-powered tools, to improve students' writing skills. Recently, AI applications such as ChatGPT have emerged as essential innovations in

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education and have proved to provide new possibilities for personalized, interactive, and engaging learning experiences in language classrooms (Chen et al., 2020). Nevertheless, there remains limited empirical evidence on their pedagogical value, especially when integrated with metacognitive strategy instruction in writing classes. Furthermore, non-English majors are rarely included in studies involving AI writing tools. This research paper hopes to contribute to the field by investigating the intersection of AI tools and metacognitive instruction in writing classes. The findings may also have practical implications for teachers in designing more effective writing lessons for non-English majors, using AI to promote the use of strategies and learning autonomy.

Literature Review

Metacognitive writing strategy instruction

Metacognitive writing strategies

Metacognition in writing, teaching, and learning demonstrates students' awareness of the writing process and the adjustments they make to successfully complete writing tasks. Building on the metacognition model of Brown et al. (1983), this study analyzed metacognitive writing strategies in three main components. Planning involves considering the audience and purpose, preparing background knowledge, brainstorming ideas, organizing them, and developing a lexical and grammatical repertoire. Monitoring refers to the continuous checking and verification of progress, in which students make decisions about content, organization, and language use as they compose their work. Evaluating involves reconsidering all the decisions students made in previous stages and reflecting on the writing process as a whole. This model served as the framework the author used to conduct classroom activities in the present study.

Metacognitive writing strategy instruction

Metacognitive writing strategies have been confirmed as essential in writing classes, supported by evidence from several studies. According to Farahian & Avarzamani (2018), planning is among the regulatory strategies of cognition that distinguish more-skilled vs less-skilled writers. Similarly, Sun et al. (2024) found that learners with "less intensive metacognitive experience" profiles showed slower writing development. To date, the benefits of teaching metacognitive strategies in writing classes have been well established (Cer, 2019; Escorcia & Gimenes, 2020; Khosravi et al., 2023; Xu & Zhang, 2023; Wang et al., 2025). Previous studies found that metacognitive instruction enhanced students' writing performance and strategy use. Additionally, Stewart et al. (2015) added that metacognitive strategies fostered greater self-confidence among students and decreased their anxiety.

Empirical evidence suggests that explicit instruction of a metacognitive strategy in writing classes offers several benefits. However, when the role of AI is considered, it remains unclear whether AI enhances students' writing performance or, conversely, whether metacognitive instruction equips students with the essential skills to use AI effectively. This issue constitutes the research gap the study aims to explore.

AI in writing classes

AI applications in L2 teaching and learning

AI, a system comprising intelligent algorithms, is presumed to possess the capacity to make human-like decisions (Akerkar, 2014; Aldosari, 2020). Research evidence suggests that AI enhances teaching methodologies and scaffolds students' language learning (Wei, 2023; Wang

et al., 2025; Yan et al., 2025). In particular, its ability to adapt to learners' individual preferences and to offer more efficient, customized learning experiences has been validated to some extent (Holmes, 2020). In addition, empirical evidence has demonstrated the advantages of AI for students' performance (Cao, 2025; Wang & Fan, 2025), and English learners have reported a relatively positive perception of using AI in classrooms (Chan & Hu, 2023; Moulieswaran & Kumar, 2023).

However, there are still warnings about the caution and responsibility when teachers and students use AI in educational settings (Karakose & Tülübas, 2023). Similarly, certain ethical concerns, including excessive use, academic dishonesty, and confidentiality, are mentioned (Crompton, 2022; Allam et al., 2023). Thus, while AI demonstrates substantial potential to enhance English language education, its implementation requires thorough consideration of ethical challenges and responsible pedagogical practices.

AI applications in English writing classes

AI, a system comprising intelligent algorithms, is presumed to be capable of making human-like decisions (Akerkar, 2014; Aldosari, 2020).-As for writing classes, AI technologies can offer students numerous advantages. A handful of studies reported the merits of using AI to improve grammatical and lexical accuracy, thanks to its capacity to provide students with instant prompts and personalized feedback (Baskara, 2023; Candilas et al., 2024). Yao et al. (2025) even highlighted debugging as a unique feature of AI when comparing students' use of writing strategies in traditional classes and in an AI-supported environment. However, research by Alzahrani and Alotaibi (2024) revealed an opposite result. The data analysis demonstrated marked improvements in coherence, cohesion, lexical resources, and general writing ability, yet a decline in grammatical precision and diversity.

In addition to providing feedback and comments, AI can be used in various ways. In a quasi-experimental study by Wale (2024), students in the experimental group achieved significantly higher performance than those in the other group, not only in syntactic accuracy but also in task completion, coherence, and cohesion. Abdullayeva and Musayeva (2023) and Utami et al. (2023) both noted the advantages of AI-supported tools during the planning stage. In addition, AI can help with summarizing (Bonner et al., 2023; Youn et al., 2024), translating (Ou et al., 2024), and paraphrasing (El-Garawany, 2024) tasks, all of which may indirectly upgrade writing performance by strengthening the ability to convey ideas clearly and coherently. Some students even noted using AI to generate new writing models (Bozkurt, 2023), which poses a potential risk to digital writing and raises questions about authenticity and integrity in writing instruction.

According to Khan et al. (2024), the use of ChatGPT was positively correlated with students' academic outcomes. The improvement in writing skills in general with the help of that tool was similarly reported in some studies (Malik et al., 2023; Pham, 2025; Tran et al., 2025).

However, considering the collective findings of prior studies, it can be observed that there are mixed results on AI's real contributions to writing instruction. Some studies have been conducted on a very small scale, involving only a few participants (Črček & Patekar, 2023; Malik et al., 2023; Candilas et al., 2024), and several of them have targeted high-level students (Črček & Patekar, 2023; Candilas et al., 2024; Tran et al., 2025). Moreover, there are few studies that guide students in navigating their own use of AI. This study thus seeks to address the aforementioned issues by concentrating on general English classes with relatively low-proficiency learners and by employing metacognitive strategy instruction to guide students in independently monitoring their AI use.

AI-Supported Metacognitive Strategy Instruction

Yan (2023) emphasized the necessity of explicit introduction on the proper use of AI tools in academic writing, while Leite et al. (2022) suggested that AI-enhanced learning tools are particularly effective in fostering students' metacognitive skills, as they can deliver individualized support that may be demanding for teachers to provide in large classroom contexts. Together, these findings highlight the importance of conducting further research on the systematic integration of AI into writing instruction, in ways that promote metacognitive awareness and ensure students receive adequate guidance on its appropriate use.

In a qualitative study with 13 postgraduate students, Yao et al. (2025) explored the role of ChatGPT in strategies such as planning, monitoring, evaluation, information management, and error correction. The findings indicated no notable differences relative to traditional teaching approaches, except in debugging, where AI showed a distinct advantage. However, Lin et al. (2025) found that AI-supported metacognitive instruction helped students understand their learning process and perform better. The mixed results *heighten the author's motivation to conduct this study to clarify whether AI-supported metacognitive instruction helps students improve* their writing outcomes.

Students' perceptions and experiences of using AI tools to support their writing

Students' engagement with and reflections on AI technologies in the context of language learning and writing instruction have been of concern recently. Tran et al. (2025) explored postgraduate students' views on using ChatGPT for academic writing and found that although learners valued its assistance in generating ideas, enhancing vocabulary, and improving grammar, they were also concerned about excessive reliance and reduced creativity. Additionally, according to Nguyen (2025), learners valued the Gemini app's accessibility and flexibility, though some experienced discomfort when its suggestions diverged from their individual writing style. In a related study, Pham and Tran (2025) observed that students generally viewed AI-assisted writing positively for its immediacy and efficiency, but questioned the reliability and consistency of its feedback.

Together, these findings suggest that students hold mixed perceptions, underscoring the need for teacher guidance to help learners critically evaluate AI feedback and maintain a balanced approach to technology integration.

Research Questions

Considering the research gaps, this study aims to investigate the effects of AI-supported metacognitive strategy instruction on the writing performance of non-English majors. This issue would be analyzed based on the two research questions as follows:

1. To what extent does AI-supported metacognitive strategy instruction improve writing performance?
2. What are students' perceptions and experiences of using AI tools to support their writing?

Methods

Pedagogical Setting & Participants

The research was conducted in two general English classes for non-English majored students in a public college in Ho Chi Minh City. Participants are mostly freshmen, with a few who have

retaken the course, and they are aged 18-20. Based on a diagnostic test delivered by the author, their general English level was identified as A1, although some seemed to be having difficulty catching up. The students were divided into two intact groups. Because the class division was pre-determined by the college, the sampling method used in this research was convenience sampling. Nevertheless, the two classes were confirmed to be comparable, as they are taught by the same instructor and share similar class size, demographic characteristics, English proficiency levels, course syllabi, and assessment requirements. As for the curriculum, this general English course is compulsory and aims to help students achieve the A2 level by the end of the course. The content includes all four essential English skills, including the target of this study: writing.

Design of the Study

This study employed a mixed-methods quasi-experimental design to investigate the effectiveness of AI-supported metacognitive strategy instruction in enhancing students' writing performance. One of the two classes was selected as the experimental group (n=39) and received AI-supported metacognitive strategy instruction. The other (n=40) was considered the control group, following the teacher-led metacognitive strategy method.

A pre-test, which required students to write a short composition of approximately 100–120 words in response to a given prompt, was conducted at the start of the course to establish a baseline for writing proficiency. Both groups then studied the same course content and dealt with similar writing tasks. Nonetheless, the experimental group was explicitly guided through the planning, monitoring, and evaluation phases, with structured prompts designed to interact with ChatGPT, the most commonly used AI application among participants. The control group was also introduced to writing metacognitive strategies, but with conventional teacher-led methods. This design was chosen to ensure that both groups were exposed to the same underlying instructional approach and to isolate the effect of the AI component as the key variable. Upon completion of the course, students were administered a post-test that paralleled the pre-test format. Some participants from the experimental group were invited to attend a semi-structured interview to share their perceptions, motivations, and experiences regarding AI-assisted writing.

Training program

The study was conducted over a period of twelve weeks. Both the control and experimental groups received the same amount of instructional time — one 45-minute session for each writing skill per week (approximately 9 hours). Students in the experimental group received metacognitive writing instruction augmented with ChatGPT. The teaching followed the three main phases of metacognitive strategy instruction, and students were guided to use the AI tool strategically at each phase. During the planning phase, students were instructed to prompt the AI to generate ideas, outline possible structures, and identify relevant vocabulary for their writing tasks. During the monitoring phase, students were guided to use AI to check progress, clarify grammar, and seek suggestions to refine their arguments. In the evaluation phase, students were asked to use AI to review coherence, vocabulary use, and organization, and to suggest revisions.

To prevent overreliance on the AI tool, students were trained to critically evaluate, accept or reject AI-generated feedback. During classroom practice, learners were required to identify AI feedback as useful, partially useful, or irrelevant, justify their decisions to accept or reject each suggestion, and revise their texts accordingly. Initially, the teacher modeled how to question AI responses, highlighting both accurate and misleading examples. Then students were encouraged

to justify their acceptance or rejection of feedback in reflective notes, promoting awareness of their decision-making process and strengthening their autonomy in using AI strategically.

Meanwhile, the control group received metacognitive strategy instruction delivered by the teacher, following the same three core phases of metacognitive instruction. The activities included whole-class discussions, brainstorming on the board, and teacher-provided planning questions, a can-do checklist, peer monitoring activities, and teacher feedback. Although the instructional structure mirrored that of the AI-supported group, the mode of support differed in that the teacher served as the principal source of guidance, feedback, and reflection, without AI tools.

Interview questions:

To enrich the quantitative analysis, 10 participants from the experimental group were randomly selected for semi-structured interviews. The aim of the interviews was to gain insights into students' opinions on how they were allowed to use AI in class. The questions were organized around the three metacognitive phases (planning, monitoring, evaluating) as well as reflection, comparison with traditional instruction, challenges, and suggestions. All interviews were conducted in Vietnamese to ensure participants' comfort and accuracy of responses. Each interview lasted 20–30 minutes and was recorded with the participant's approval. The audio data were then transcribed, translated into English, and subjected to thematic analysis.

Data collection & analysis

Pre- and post-tests were marked by two separate examiners using the same scoring rubric, which assessed five key criteria: content, organization, vocabulary, grammar, and mechanics, each rated on a five-point scale (1 = very limited to 5 = excellent). Then, paired-samples t-tests were used to assess within-group improvement, and independent-samples t-tests were used to evaluate differences between the experimental and control groups. Besides, qualitative data from interviews were transcribed and analyzed to identify patterns in students' perspectives of the target teaching method, including perceived benefits, challenges, and comparisons with traditional instruction.

Results/Findings

Data normality

Prior to analysis, Shapiro-Wilk tests were performed on both groups to assess whether the writing pre-test and post-test scores were normally distributed.

Table 1

Tests of Normality of pre-test scores

	Group	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Pre-test scores	Experimental	.197	39	.001	.900	39	.002
	Control	.183	40	.002	.881	40	.001

As shown in Table 1, the pre-test scores of both groups have $p<0.05$ (experimental group: $p=0.002$; control group: $p=0.001$). This suggests that pre-test scores are non-normal in both groups. Similarly, the post-test scores in the experimental group have $p = 0.036$, and those in the control group have $p = 0.004$ according to Table 2. Both are less than 0.05, indicating that

the post-test scores significantly deviate from normality.

Table 2

Tests of Normality of post-test scores

	Group	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Post-test scores	Experimental	.156	39	.018	.939	39	.036
	Control	.189	40	.001	.912	40	.004

However, the sample sizes exceed 30 participants (n=39 in the experimental group and n=40 in the control group), so, given the t-test's robustness to moderate violations of normality in larger samples (Field, 2018), the analysis proceeds with parametric tests.

Research question 1: To what extent does AI-supported metacognitive strategy instruction improve writing performance?

Table 3 summarizes the mean scores and standard deviations of pre-test and post-test writing scores for both groups. It can be observed that the mean score of pre-tests in both groups is 4.9, which signifies that the two groups are comparable before the intervention. Mean scores differ across post-tests. At first glance, it can be seen that the mean scores in each group show a clear improvement (+1.7 for the experimental group and +0.9 for the control group). Additionally, the experimental group outperformed the other group, with mean scores of 6.6 (SD = 1.35) and 5.8 (SD = 1.11), respectively. This proposes that students who received AI-supported metacognitive strategy instruction demonstrated greater gains in writing performance than those who received teacher-led instruction.

Table 3

Descriptive statistics of writing scores in the control and experimental groups

Group	**n**	**Pre-test Mean (SD)**	**Post-test Mean (SD)**
Experimental	39	4.9 (1.34)	6.6 (1.35)
Control	40	4.9 (1.45)	5.8 (1.11)

An independent-samples t-test was then performed to assess whether AI-supported metacognitive strategy instruction led to a statistically significant improvement in students' writing performance (Table 5). The non-significant result of Levene's test (p = .098) confirmed that the assumption of homogeneity of variances was not violated. The independent-samples t-test indicated a significant difference in post-test scores between the experimental and control groups ($p = 0.006 < 0.01$). This suggests that integrating AI into metacognitive strategy instruction had a positive impact on students' writing performance compared with traditional instruction.

However, to determine whether this result was statistically significant, parametric tests were conducted after the descriptive analysis. To examine changes in students' writing performance within groups, a paired-samples t-test was applied between the pre-test and post-test. For the control group, the post-test mean score was markedly higher than the pre-test mean score with $t(39) = -3.94$, $p < .001$. This suggests that traditional instruction yielded a modest yet statistically significant improvement in writing performance. In the experimental group (n =

39), students' writing performance showed marked progress. Their mean score rose from 4.9 (SD = 1.34) in the pre-test to 6.6 (SD = 1.35) in the post-test. This 1.64-point increase was statistically significant, $t(38) = –8.52$, $p < .001$, reflecting a considerable improvement in overall writing ability. In sum, both groups made significant progress, but the experimental group outperformed the control group overall. (see Table 4).

Table 4

Paired Sample t-test of the control group and experimental group

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Control group	Pre-test -Post-test	-.90000	144.648	.22871	-136.261	-.43739	-3.935	39	.000
Experimental group	Pre-test -Post-test	-164.103	120.279	.19260	-203.092	-125.113	-8.520	38	.000

Table 5

Independent samples t-test result

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Post test	Equal variances assumed	2.805	.098	2.837	77	.006	.78974	.27838	.23541	1.34408
	Equal variances not assumed			2.830	73.561	.006	.78974	.27907	.23363	1.34585

To ensure the robustness of the findings, nonparametric tests were also conducted given the nonnormal distribution of the data. The Wilcoxon Signed-Rank Test (for within-group comparisons) and the Mann–Whitney U Test (for between-group comparisons) produced results consistent with those from the parametric analyses. Specifically, both tests confirmed significant improvements in writing performance within each group and a statistically significant difference in post-test scores between the experimental and control groups. These consistent results across both parametric and non-parametric tests further strengthen the reliability of the findings.

Research question 2: What are students' perceptions and experiences of using AI tools to support their writing?

To address the second research question, a semi-structured interview was conducted, and its results shed light on students' beliefs, experiences, difficulties, and considerations regarding the use of AI tools in writing classes. Overall, most students admitted that AI provided benefits at different stages of the writing process. Student 8 clarified that AI helped her to *"brainstorm ideas quickly, suggested relevant vocabulary and grammar structures, provided feedback in a very clear and comprehensible way"*. In addition, students 5 and 7 emphasized the convenience

and time-saving advantages of AI tools, while student 4 valued the fact that she could learn from how AI suggested ideas for her writing and applied the same approach to make an outline by herself.

Planning

To be more specific, students highlighted AI's role in planning their writing work. Some students shared the difficulties when planning ideas without AI's assistance. For example, student 4 explained that she usually struggled with brainstorming and organizing ideas in a non-AI class. Student 7 said he had to spend too much time planning his writing work on his own, so AI helped him save time on this step. Besides, most students underscored the speed with which AI generates ideas and the logical arrangement of ideas in the suggested outlines. In particular, student 6 thought the ideas suggested by AI seemed *"more complete and profound"*. Meanwhile, student 5 said he could learn from AI *"new ideas and knowledge about a topic"*. In sum, there is a sound agreement that AI is really beneficial in the planning stage.

Monitoring

As for the monitoring stage, almost all students have a positive attitude toward AI's value in supporting them as they navigate their writing process, which is generally non-linear and complex. Most students mentioned AI's strengths in checking spelling, lexical and grammatical use, and paraphrasing. Some of them noted that it could guide them on whether they closely followed the outline and fully supported their ideas (students 5, 8, 10). Student 5 referred to passive forms and used "it" as examples of structures he rarely used in his writing without AI, and he asserted that this made him feel *"more academic"*. Additionally, students 2, 3, and 4 reported that AI improved their grammatical knowledge by providing clear explanations for its corrections. Student 6 even regarded AI as his *"savior,"* while student 2 described, *"AI is just like a tutor who could be by my side throughout my writing process*." These notions indicate that students really appreciate the value of AI in writing assignments.

Evaluating

Unlike the other two stages in the writing metacognitive strategy process, students exhibited varied perceptions of AI's role in evaluating their writing performance. While the majority of students confirmed using AI in the evaluation phase, they expressed differing opinions on its accuracy and reliability, and several expressed doubts about its ability to assess performance. On the one hand, students 1 and 6 stated that they *"completely"* or *"almost completely"* believed in AI's evaluation. Student 6 even regarded AI as *"an expert"* whom he knew apart from teachers. On the other hand, the other students just *"partly"* or *"relatively"* trusted the assessment made by AI. Particularly, Student 2 estimated his level of trust at 50%, while Student 4 noted it at 70%. Students 5 and 8 explained that AI can perform well at assessing spelling and language use, but it sometimes makes mistakes in judging content. Similarly, student 9 shared,

> *"we must be very careful and critical to select which content-related recommendations should be considered and which should be disregarded"*.

Meanwhile, students 2, 4, and 10 preferred human evaluation, such as self-evaluation, peer feedback, and teachers' feedback, over AI evaluation. To conclude, it is clear that students had varied views on AI's evaluation.

AI-supported versus teacher-led metacognitive strategy in writing classes

Almost all interview participants acknowledged the benefits of AI-supported methods. When asked which was AI's most essential contribution to their writing skills, students listed different options. To be more specific, students 2, 5, 6, and 7 valued the ability to suggest relevant

grammar structures and vocabulary, while students 1, 3, 4, and 8 highlighted the potential to generate interesting ideas and organize them in a logical order. Additionally, students 9 and 10 both agreed that AI performed well in correcting mistakes.

Besides that, all interviewees admitted that AI boosted their confidence in their writing skills and that they wanted to keep using it in the future. Student 2 considered the experience with AI in writing classes was *"very interesting"*. Students 1, 4, 5, and 7 emphasized that AI helped them with their self-study by allowing them to study *"at any time"* and to repeat their study process *"repeat many times until they really acquire the lesson"*. These participants believed that it would be too difficult for teachers to consistently and individually support them in that way.

Regarding the comparison between AI-supported and teacher-led metacognitive strategies in writing classes, students had quite diverse ideas. Students 3, though they agreed on AI's benefits, still preferred teacher-led lessons. He said:

> *"The traditional teaching approach is more direct, which helps me absorb knowledge more easily because teachers provide face-to-face instruction, point out mistakes, and support me in learning how to write."*

Whereas students 6 and 8 took a more balanced position. On one hand, they endorsed the AI-supported method as a breakthrough; on the other hand, they thought the traditional method was *"more emotional"*, helped students *"practice critical thinking"*, and was *"irreplaceable"*. The other students in the interview, conversely, assumed that the AI-supported method outperformed the traditional one, especially in terms of time efficiency and personalization.

Challenges and suggestions.

Participants shared several considerations and challenges when using AI to support their writing. Some students doubted the accuracy of AI-generated information, particularly when they asked it to provide relevant evidence to support an argument. For instance, student 8 shared that she always had to double-check the information in other resources to ensure its accuracy. Moreover, most students fear that heavy reliance on AI could undermine their ability to reason autonomously. Student 2 admitted that he was *"tempted"* to use AI more than he expected, and he was concerned about a decline in his mental sharpness. Similarly, student 5 was concerned that his *"creativity" might decline* due to excessive reliance on AI, and student 8 was apprehensive about the *"naturality"* of his skill improvement. Unlike the other students, student 6 acknowledged a few difficulties when using AI in writing class. He said, *"I know what to ask AI and how to manage my learning process."* Nevertheless, he was himself well aware of *"the risk of becoming overly reliant on AI and diminishing one's own critical thinking"*.

When asked about the suggestions for the AI-supported metacognitive method, students appreciated the teacher's effort to guide them in using AI effectively. For instance, according to student 8,

> *"Teachers' instruction on the limitations and the objectives of AI usage played a significant role because it helped me avoid over-reliance on the tool and encouraged me to use AI more strategically to support, rather than replace, my own writing process."*

Students 1, 6, and 10 expressed a desire for more detailed guidance on effective prompts they could use when interacting with AI. Most students emphasized that the most important point in this approach is that teachers should stress that AI is only a supporting tool, and that encouraging students to think independently must come before relying on AI.

Discussion

This study aims to examine the effects of AI-supported metacognitive strategy instruction on the writing performance of non-English majors by addressing two research questions.

Research question 1: To what extent does AI-supported metacognitive strategy instruction improve writing performance?

The quantitative results indicated a statistically significant improvement in students' performance in both groups; however, the experimental group showed a more substantial improvement, suggesting that AI may enhance the writing performance of non-English majors when integrated into metacognitive instruction. Regarding metacognitive instruction in writing, previous studies have highlighted the importance of metacognitive strategies in enhancing writing skills (Cer, 2019; Escorcia & Gimenes, 2020; Khosravi et al., 2023; Xu & Zhang, 2023; Wang et al., 2025). The present study appears to support this claim by showing a tendency toward improvement in both groups following metacognitive instruction. Considering both metacognitive strategy methods and AI, the study's findings align with previous research suggesting that AI-supported metacognitive instruction may help students perform better in writing classes (Malik et al., 2023; Alzahrani & Alotaibi, 2024; Lin et al., 2025). The findings also extend earlier work by providing additional insights into the performance of low-level non-English majors, based on a reasonable sample size of nearly 80 participants. Furthermore, because the research design used AI as a key variable that is supposed to primarily affect the final result, this study may offer a clearer indication of AI's potential contribution when implemented alongside metacognitive instruction.

Some possible reasons for the impact of AI-supported metacognitive instruction include AI's notable feature: immediate and personalized feedback. It reduces waiting time compared to teacher-led metacognitive instruction. Students don't have to wait for teacher-only feedback in a relatively crowded class (about 40 students per class). Hence, they have more time to practice, not to mention the possibility of self-learning outside the classroom. Additionally, during the planning and monitoring stages, AI may help ease the mental load and reduce anxiety, allowing students to prioritize content development and structural organization.

However, the control group showed an essential improvement with the teacher-led metacognitive method, although it was less than with the target method. This suggests the scaffolding effect of AI and, at the same time, reminds us that AI can complement, not replace, teachers.

Research question 2: What are students' perceptions and experiences of using AI tools to support their writing?

The qualitative results focused more on students' perceptions and experiences regarding AI use. Generally, students valued AI's role across all stages of writing and regarded it as time-saving, idea-generating, and confidence-boosting. Regarding planning, most students agreed that AI enabled them to brainstorm and organize ideas more efficiently, which aligns with the previous findings of Abdullayeva and Musayeva (2023) and Utami et al. (2023). During the monitoring stage, AI was often described as "like a tutor," providing explanations, corrections, and models for students to learn from. However, in the evaluation stage, students expressed mixed levels of trust. While some regarded AI feedback as highly reliable, others questioned its accuracy, particularly in assessing the quality of content and argumentation. This result appeared to be consistent with the findings of Yao et al. (2025) who emphasize the effect of debugging as AI's distinct advantage, while also noting its limitations in providing nuanced evaluative feedback on meaning and coherence (Tran et al., 2025).

When comparing AI-supported instruction with a teacher-led approach, students expressed diverse views. Some participants valued traditional instruction for its emotional dimension, interactivity, and support in developing critical thinking. Others highlighted AI's strengths in speed, personalization, and independence. Several students adopted a balanced perspective, indicating that AI is meant to aid, not replace, teacher feedback. Despite the positive perceptions, students also identified challenges and risks. Concerns were raised about AI's accuracy, the potential loss of creativity, and the danger of over-reliance, which were mentioned previously by several studies (Bozkurt, 2023; Candilas et al., 2024; Tran et al., 2025). Participants stressed the importance of teacher guidance, particularly in showing students when and how to use AI effectively. This confirms Yan (2023)'s notion of the necessity of explicit AI-guided use.

These insights suggest that while AI cannot replace teacher-student interaction, it can meaningfully enhance students' autonomy and metacognitive engagement when integrated into a blended approach that combines AI support with teacher scaffolding.

Conclusion

Summary of the findings

This study examined the impact of AI-supported metacognitive strategy instruction on the writing performance of low-level non-English majors and students' perceptions of AI's contribution to their writing process. The quantitative results indicated that both the experimental and control groups improved after the training course, but the gains appeared to be significantly greater in the AI-supported instruction group. This suggests that integrating AI tools into metacognitive training can meaningfully enhance students' writing performance beyond what traditional methods achieve.

The qualitative findings provide further insight into how students experienced this approach. Participants generally valued AI's support across different stages of writing: it seemed to help them generate and organize ideas more quickly, monitor their progress with immediate feedback, and evaluate their work with increased confidence. However, perceptions of AI's evaluation were mixed, with some students questioning its accuracy in assessing content and argument quality. While many students appreciated AI's speed, personalization, and availability, others highlighted the irreplaceable role of teacher-led instruction in providing emotional support, fostering critical thinking, and offering more reliable feedback.

Taken together, the findings suggest that AI, when guided by metacognitive strategies, appears to be a powerful tool for improving writing outcomes and fostering learner autonomy. At the same time, the study highlights the need for an integrated yet balanced approach in which AI serves as a supplement to, rather than a substitute for, teacher support. This blended approach may offer the most sustainable path forward in developing students' writing skills.

Limitations

Even though the results seem promising, there are a few limitations to consider. Firstly, the performance boost in the experimental group might not be entirely due to the teaching method—it's possible that students were excited to try a new technology, which made them more engaged. That kind of novelty can definitely influence outcomes. Also, not every student had the same level of experience using AI tools. Those who were already familiar with them may have had an advantage in the intervention. Finally, statistical analysis revealed that neither the pre-test nor the post-test scores were normally distributed. Although the sample size was

sufficiently large (over 30 participants per group) and the t-test is known for its robustness, the application of parametric tests requires careful consideration. These limitations do not undermine the validity of the findings but indicate the need for careful interpretation and replication in future studies.

Suggestions for future research.

It would be valuable for future research to explore whether the positive effects of AI-supported metacognitive strategy instruction are sustained over time, particularly given that some of the initial improvements may be linked to the novelty of using new technology. It is also important to consider students' prior experience with AI tools. Also, expanding this approach to learners at varying language proficiency levels or in different academic contexts could help determine its broader applicability. From a methodological standpoint, studies incorporating larger sample sizes, randomized group assignments, or mixed-method designs would strengthen the validity and thoroughness of the findings.

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