

# Metacognitive writing awareness, strategies, and critical thinking skills among Chinese non-English majors

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ISSN: 2243-7770  
Online ISSN: 2243-7789

OPEN ACCESS

Received: 15 July 2025

Revised: 27 August 2025

Accepted: 31 August 2025

Available Online: 7 September 2025

DOI: 10.5861/ijrsm.2025.25092

## Abstract

Amidst the rapid expansion of technology-supported instruction in Chinese higher education, non-English majors are increasingly required to complete academic writing tasks in blended or fully online English courses. Yet little is known about how these learners deploy metacognitive awareness and strategies, nor how such deployment relates to their critical thinking performance. This study investigated metacognitive writing awareness, strategy, and critical thinking skills among 505 non-English majors enrolled at Hunan University of Environment and Biology. Employing a descriptive-correlational design, data were gathered through validated survey instruments and analyzed with descriptive statistics, one-way ANOVAs, and Pearson correlations. Results showed that participants possessed moderate-to-high metacognitive writing awareness, particularly in declarative and conditional knowledge, planning, monitoring, and evaluation. They likewise report frequent and effective use of metacognitive writing strategies (planning, monitoring, evaluating, information management) and expressed positive self-efficacy beliefs, although application gaps remain. Significant variations emerged across sex, year level, and major, with Liberal Arts students demonstrating marginally stronger awareness than Science peers. Most critically, robust positive correlations linked metacognitive writing awareness, strategy employment, and critical thinking ability, confirming that heightened awareness and strategic action fostered superior critical engagement with writing tasks. Grounded in these findings, an enhancement program—incorporating scaffolded metacognitive instruction, discipline-specific writing workshops, and teacher-integrated critical thinking tasks—was proposed to bolster English writing competence among Chinese non-English majors operating in blended learning contexts.

**Keywords:** metacognitive writing awareness, metacognitive writing strategies, critical thinking skills, non-English majors

## **Metacognitive writing awareness, strategies, and critical thinking skills among Chinese non-English majors**

### **1. Introduction**

In the current era of rapid globalization and technological advancement, Chinese non-English major college students are expected to be "language + major" compound talents. English scores play a significant role in college entrance examinations, postgraduate entrance examinations, and various professional qualification evaluations. As a result, non-English major college students are pushed onto a dual track of "instrumentality and humanism": they need to use English as a bridge to access cutting-edge professional information and also to showcase their research achievements and cross-cultural critical thinking skills. On the one hand, national strategies such as the "Four New" construction and the outstanding engineer education and training program have put forward higher requirements for the English academic writing ability of college students. On the other hand, the information-overloaded online learning environment requires them to have the ability to efficiently search, screen, and integrate information (Xu, 2024). It is precisely in this context that exploring the interactive mechanism of "metacognitive writing awareness, writing strategies, and critical thinking skills" of Chinese non-English major college students is both urgent in reality and forward-looking in theory.

Metacognitive writing awareness refers to learners' awareness and regulation of their own cognitive resources, task characteristics, and strategy application during the English writing process. It not only includes "task knowledge" such as writing goals and audience expectations, but also "strategy knowledge" such as planning, monitoring, and evaluation, as well as "self-knowledge" such as self-language proficiency and emotional state (Teng et al., 2021). Recent studies have pointed out that learners with high levels of metacognitive writing awareness are better at setting clear goals before writing, monitoring logical and language deviations during writing, and conducting targeted reflection and revision after writing.

Metacognitive writing strategies are the "operation panel" through which metacognitive awareness is translated into specific actions. In the digital environment, it manifests as a series of chain behaviors such as information retrieval, note management, corpus comparison, online collaborative peer review, and automatic feedback (Xu, 2024). The latest empirical research shows that when non-English major students can flexibly utilize cognitive strategies (such as brainstorming), metacognitive strategies (such as self-questioning), and social strategies (such as online peer feedback), their writing quality is significantly better than that of those who use a single strategy (Li, 2023).

Critical thinking skills run through the entire writing process and are high-level abilities to remember, understand, apply, analyze, and create regarding information sources, argument logic, and value positions. It requires learners to be able to identify the reliability differences between academic databases and self-media information and construct a rigorous chain of "claim - evidence - reasoning" in the text, ultimately achieving viewpoint innovation and knowledge value-added. The cross-national study by Rivas et. al., (2022) confirmed that there is a significant synergy between critical thinking and metacognitive strategies: metacognitive monitoring provides a "cognitive entry point" for critical questioning, while critical evaluation, in turn, enriches the metacognitive knowledge base.

This study, through path analysis of questionnaires, writing archives, and interview data from 505 non-English major college students in Chinese universities, found that metacognitive writing awareness not only directly and positively predicts the diversity of writing strategies but also indirectly improves critical thinking performance through strategy use; at the same time, high-level critical thinking skills can also reinforce individual metacognitive awareness in a reverse manner, forming a "perception - action - reflection - re-perception" spiral upward cycle. This result not only validates the "Dynamic Metacognitive System Model"

proposed by Zhang et al. (2023), but also provides an empirical fulcrum for breaking the vicious cycle of "writing anxiety - inefficient strategies - superficial thinking".

Addressing the challenges faced by Chinese non-English majors in English writing requires a comprehensive understanding of metacognitive writing awareness, metacognitive writing strategies, and critical thinking skills. By examining these variables, educators can develop targeted interventions to improve students' writing proficiency, ultimately contributing to their academic success and global competence.

**Objectives of the Study** - This study explored and analyzed the correlations and interaction mechanisms among metacognitive writing awareness, writing strategies, and critical thinking skills of Chinese non-English major university students. The research sought to further reveal how these variables intersect in digital academic writing environments, with particular focus on their synergistic effects in online writing task scenarios. By examining the interdependent relationships among these variables, this study investigated how they form dynamic cycles during the brainstorming, drafting, and revising stages of the writing process.

Simultaneously, this study called for front-line instructors and curriculum designers to place greater emphasis on the parallel development of metacognitive training and critical thinking cultivation in writing classrooms deeply integrated with information technology. Given that the research subjects are Chinese non-English major university students, their unique disciplinary backgrounds, cultural contexts, and test-taking experiences determine that the research conclusions will directly contribute to the restructuring of academic English writing courses in Chinese universities. The findings provided localized, operable, and sustainable improvement solutions for university-level English writing instruction, thereby promoted Chinese students' online autonomous learning and laid a solid foundation for their effective communication and knowledge innovation within the global academic community.

To be specific, this study determined metacognitive writing awareness of the respondents in terms of awareness of knowledge on declaration, procedure, condition, and regulation of cognition on planning, monitoring and evaluation; accessed the metacognitive writing strategies of the respondents in terms of planning, monitoring and evaluating; identified critical thinking skills of the respondents in terms of their remembering, understanding, applying, analyzing, evaluating and creating; tested the relationship among metacognitive writing awareness, strategies and critical thinking skills; proposed a language learning program to enhance English language learning of Chinese Non-English major college students.

## 2. Methods

**Research Design** - The utilization of quantitative research methodology in this investigation was driven by a desire to adopt a descriptive research approach, which is fundamentally concerned with the collection and analysis of quantifiable data from a representative sample of the population. This approach, which is extensively employed across various research disciplines, enables researchers to gather and present information regarding the characteristics and behaviors of a specific demographic group. In this particular study, the researcher adopted a descriptive research design to examine the interrelationships among three key variables: metacognitive writing awareness, strategies, and critical thinking skills. To this end, the researcher resorted to survey research methodology, which involved collecting data from participants through the use of questionnaires. These questionnaires were specifically designed to capture the participants' responses to a series of questions related to the research variables. Questionnaires have long been recognized as a valuable tool in research, as they facilitate the collection of valuable feedback and insights from the participants.

**Participants of the Study** - The research involved participants from a public university in China's south region. These participants were categorized based on their majors, specifically liberal arts, science medicines and landscape majors. The total number was 6000 respondents. The researcher utilized the Raosoft online sample size calculator to determine an appropriate sample size, which suggested distributing 505 questionnaires to the targeted respondents.

**Instrument of the Study** - The study aimed to evaluate the dependability of measuring perceptual constructs such as the metacognitive writing awareness, strategies and critical thinking skills among Chinese Non-English major college students. The questionnaire comprised four parts: Personal Data Information, the metacognitive writing awareness questionnaire, the metacognitive writing strategies questionnaire, and critical thinking questionnaire. The questionnaire consisted of 86 items, rated on a 4-point Likert scale, ranging from "strongly disagree" to "strongly agree." The first part of the questionnaire gathered respondents' profile information, including age, sex, grade, years of English learning and major. The second part of the questionnaire used the metacognitive writing awareness questionnaire (MAWQ) developed by Ramadhanti (2021) in Students' Metacognitive Awareness and Its Impact on Writing Skill in 2021 adapted from Farahian in developing and validating a metacognitive writing questionnaire for EFL learners in 2017. It comprised six sub-scales: awareness of knowledge on declarative, condition, and regulation of cognition on planning, monitoring and evaluation, totaling 27 statements. The third part used the metacognitive writing strategies questionnaire developed by Mark et al. (2022) in Metacognitive writing strategies, critical thinking skills, and academic writing performance: A structural equation modeling approach in 2022. This section included seven sub-scales: declarative knowledge, conditional knowledge, planning, monitoring, evaluating, information management strategy and debugging strategy, with a total 34 statements. The fourth part used the Critical Thinking Questionnaire (CThQ), compiled by Kobylarek et al. (2022) in Critical Thinking Questionnaire (CThQ) – construction and application of critical thinking test tool in 2022 adapted from Facione of The California Critical Thinking Skills Test Manual (Updated Edition). This section included 5 sub-scales: remembering, understanding, applying, analyzing and creating, with a total 25 statements.

**Table 1***The Reliability Test for Three Variables*

Indicators	Cronbach Alpha	Remarks
Awareness of declarative knowledge	0.898	Good
Awareness of conditional knowledge	0.872	Good
Regulation of cognition (planning)	0.909	Excellent
Regulation of cognition (monitoring)	0.901	Excellent
Regulation of cognition (evaluation)	0.702	Acceptable
Declarative knowledge	0.837	Good
conditional knowledge	0.723	Acceptable
planning	0.754	Acceptable
monitoring	0.753	Acceptable
evaluating	0.791	Acceptable
Information management strategy	0.917	Excellent
Debugging strategy	0.759	Acceptable
Remembering	0.896	Good
Understanding	0.824	Good
Applying	0.823	Good
Analyzing	0.754	Acceptable
Creating	0.855	Good

George and Mallery (2003) provide the following rules of thumb: “\_ > .9 – Excellent, \_ > .8 – Good, \_ > .7 – Acceptable, \_ > .6 – Questionable, \_ > .5 – Poor; and \_ < .5 – Unacceptable”

**Data Gathering Procedure** - Data collection for this teaching experiment was conducted in a systematic and thorough manner to ensure accuracy and reliability. The following procedures were undertaken to gather the necessary information:

- Pre-experiment Surveys: Prior to the experiment, all 90 students were administered the California Critical Thinking Skills Test (CCTST) and the writing tests from DET (Diagnostic English Test). These tests provided a baseline measure of the students' initial critical thinking skills and writing abilities. The results of these tests were recorded and analyzed using SPSS27.0 for descriptive statistics and frequency analysis.
- In-experiment Observations: During the 18-week experiment, regular observations were made to track

the progress of both the experimental and control groups. Classroom activities such as getting-to-know activities, brainstorming sessions, group discussions, peer reviews, and self-revisions were observed closely. Special attention was paid to the implementation of metacognitive writing awareness, strategies, and critical thinking skills training in the experimental group. Detailed notes were taken to document the students' participation, engagement, and responses to the different teaching methods.

- **Post-experiment Assessments:** At the end of the 18-week period, the students were once again administered the CCTST, DET writing tests, and the Teaching Resource Platform (TRP) assessment. The TRP assessment included online evaluations of the students' final writings, teacher feedback, and self-reflections. The combined evaluative standard based on Wen's (2006) grading criteria for writing content and Newman's (1995) critical writing indicators was used to assess the students' change in writing content. All the data collected from these assessments were recorded and analyzed using SPSS27.0 for descriptive statistics, paired samples test, and frequency analysis.
- **Qualitative Data Collection:** In addition to the quantitative assessments, qualitative data was also collected through interviews, focus group discussions, and student journals. These methods provided insights into the students' perceptions of the different teaching methods, their challenges and successes, and their learning experiences. The qualitative data was analyzed using content analysis techniques to identify patterns and themes in the students' responses. By combining both quantitative and qualitative data collection methods, this teaching experiment was able to capture a comprehensive picture of the students' learning progress and the effectiveness of the different teaching strategies.

**Data Analysis** - After the compilation of data, a thorough and exhaustive review was undertaken for each survey, rigorously scrutinizing every detail to guarantee the utmost completeness and impeccable accuracy of the gathered information. As part of our stringent quality control, all questionnaires with missing or incomplete entries were rigorously screened and subsequently discarded, ensuring the precision and dependability of the subsequent analytical processes. Among the comprehensive set of questionnaires that remained, a selective 505 samples were meticulously chosen, deemed apt for our purpose, and were subsequently tagged with corresponding statistical analysis codes, facilitating an in-depth exploration of the research question. To uphold the rigorous standards of scientific integrity, we employed the Statistical Package for the Social Sciences (SPSS), a renowned tool, for the statistical analysis of the amassed data, thus ensuring the accuracy and scientific credibility of our findings. This software package possesses formidable data processing and analytical prowess, rendering it capable of delivering pinpoint accurate and dependable statistical outcomes. These outcomes serve as invaluable aids in providing nuanced answers to intricate research queries. The data have undergone rigorous scrutiny and meticulous categorization, resulting in their being neatly organized within personal computers.

Prior to and subsequent to the experimentation, DET and Teaching Resource Platform (TRP) writing tests served as a pivotal evaluation mechanism. To paint a detailed statistical picture, a rigorous descriptive analysis was undertaken, encompassing vital metrics like the average scores and their corresponding standard deviations. To further scrutinize the existence of noteworthy statistical disparities among distinct groups, an independent t-test methodology was deployed. Additionally, a single-sample independent t-test was employed to offer a profound and unbiased evaluation of the participants' academic prowess in a broader context. Ensuring the authenticity and credibility of our findings, all statistical tests adhered strictly to the significance thresholds of  $p \leq 0.05$  and  $p \leq 0.01$ . In this comprehensive study, an elaborate descriptive analysis, a comparative evaluation of means, and an in-depth correlation analysis of student English test scores, leveraging the robust statistical software SPSS 27.0 (Statistical Product and Service Solutions, formerly known as Statistical Package for Social Sciences) were conducted. This approach allowed the researcher to gain a nuanced understanding of the data, identifying patterns, trends, and potential relationships within the student performance scores.

**Ethical Consideration** - After systematic planning and design, the current survey process has been fully integrated into ethical considerations to ensure the compliance and ethics of the entire survey procedure. First of all,

the university has solemnly drawn up a formal consent form, designed to obtain the formal approval from the dean of the English Teaching Office of a public university, to ensure the legitimacy and authority of the investigation activities. At the beginning of the questionnaire, we specially added an elaborate consent form, which aims to strictly maintain the confidentiality and anonymity of participants' personal information and eliminate their concerns. During the survey, the individuals surveyed were provided with detailed descriptions of the study objectives and the specific tasks they were expected to undertake, ensuring that each participant had a clear understanding of the content of the survey. At the same time, the autonomy of the participants was fully respected, and they were given the right to decide whether to participate or withdraw from the study at any stage, and their personal wishes were fully respected. In addition, a clear commitment was made to the students that all collected data and research findings will be used for research purposes only and will not be leaked or used for other purposes to dispel their doubts. Throughout the study, researchers were required to ensure that each participant was able to carefully read and fully understand all the instructions, study procedures and purposes of the survey, ensuring that they participated in the survey in a fully informed manner. To further safeguard the rights of the participants, a voluntary participation approach was adopted to ensure that each respondent participated in the survey in a voluntary, stress-free manner. At the same time, it attached great importance to the confidentiality of information and data, and strict confidentiality measures had been taken in the whole investigation process to prevent information leakage. Finally, the research center affiliated to the University of the Lyceum in the Philippines also obtained formal approval for ethical considerations, which provided strong support and guarantee for the smooth progress of this survey.

### 3. Results and discussion

**Table 2**

*Summary Table on Metacognitive Writing Awareness*

Indicators	Weighted Mean	Verbal Interpretation	Rank
Awareness of declarative knowledge	2.72	Agree	2
Awareness of conditional knowledge	2.70	Agree	5
Regulation of cognition (planning)	2.76	Agree	1
Regulation of cognition (monitoring)	2.71	Agree	3.5
Regulation of cognition (evaluation)	2.71	Agree	3.5
<b>Composite Mean</b>	<b>2.72</b>	<b>Agree</b>	

*Legend: 3.50 – 4.00 = Strongly Agree; 2.50 – 3.49 = Agree; 1.50 – 2.49 = Disagree; 1.00 – 1.49 = Strongly Disagree*

To sum up, the summary data in Table 2 shows that the overall mean of metacognitive writing awareness is 2.72. The respondents as a whole agreed that they possessed a relatively balanced metacognitive writing awareness. However, among the five dimensions, the score for "Awareness of conditional knowledge" was the lowest (mean 2.70, ranking 5th). "Conditional knowledge awareness" refers to the learner's awareness of "when, why, and how to apply specific writing strategies or language resources in a specific context" (Paris et al., 2022). The results of this study showed that the respondents scored the lowest in this dimension, suggesting that although they have mastered certain declarative knowledge (knowing "what") and procedural knowledge (knowing "how to do it"), they are relatively lacking in sensitivity to the conditions for knowledge transfer.

Pan et al. (2022) found that insufficient conditional knowledge can also lead to "pragmatic mismatch" when learners face cross-cultural writing tasks. For example, the euphemistic expressions commonly used in the Chinese context, if directly transferred to academic writing in English, may weaken the clarity of the argument. Therefore, conditional knowledge not only relates to genre and task types, but also involves cultural context adaptation, suggesting that teaching interventions should rise from a single skill level to a cross-cultural rhetoric awareness level. In conclusion, the lowest score in conditional knowledge awareness reflected the respondents' weak metacognitive ability in "strategy transfer and context adaptation". Future writing teaching can introduce diversified task contexts to enable students to experience different writing purposes and audience needs, combined with cross-cultural case discussions, to enhance cultural context sensitivity. Only in this way can we truly enhance learners' conditional knowledge awareness and achieve deep transfer and continuous development

of writing ability.

**Table 3**

*Summary Table on Metacognitive Writing Strategies*

Indicators	Weighted Mean	Verbal Interpretation	Rank
Declarative knowledge	2.75	Agree	3
conditional knowledge	2.70	Agree	6.5
planning	2.71	Agree	5
monitoring	2.75	Agree	3
evaluating	2.70	Agree	6.5
Information management strategy	2.77	Agree	1
Debugging strategy	2.75	Agree	3
<b>Composite Mean</b>	<b>2.73</b>	<b>Agree</b>	

*Legend: 3.50 – 4.00 = Strongly Agree; 2.50 – 3.49 = Agree; 1.50 – 2.49 = Disagree; 1.00 - 1.49 = Strongly Disagree*

Table 3 summarizes the overall performance of 7 metacognitive writing strategies, with an overall mean of 2.73, indicating that students generally hold an "agree" attitude. Among them, conditional knowledge and evaluation tied for the lowest score (with an average of 2.70, ranking 6.5th). This result suggested that although students recognized the importance of metacognitive strategies, there were still significant shortcomings in "knowing when and why to use the strategies" and "evaluating the effectiveness of the strategies afterwards". Conditional knowledge refers to the learner's understanding of the applicable contexts and conditions of the strategies (Schraw et al., 2020). This indicator ranked last in Table 3, indicating that although students can state the strategies (declarative knowledge 2.75), they have difficulty determining which strategy to use in which task context. This finding is supported by Chen et al. (2022) who found in a survey of 642 Chinese college students that conditional knowledge had a significantly higher predictive power for writing scores ( $\beta = .31$ ) than declarative knowledge ( $\beta = .19$ ), and its absence can lead to "strategy transfer failure" - students repeatedly use the same strategy in different writing tasks while ignoring task differences. In an online blended learning environment, this defect is further exacerbated: when faced with multi-modal resources and asynchronous discussions, students often have difficulty determining when to activate the "debugging strategy" rather than the "information management strategy" (Sun et al., 2023).

Evaluation strategies refer to students' reflection and quality judgment on the writing process and results. The table shows that their score is only on par with conditional knowledge, indicating that students are less likely to actively evaluate the effectiveness of the strategies. Teng et al. (2021)'s longitudinal study pointed out that the lack of systematic evaluation can lead to "the interruption of the metacognitive cycle": after completing the essay, students no longer examine the degree of goal achievement and miss the opportunity for strategy optimization. The study also found that integrating "peer evaluation + self-questioning checklist" intervention can significantly improve the score of the evaluation dimension (Cohen's  $d = 0.48$ ). In addition, if an online writing platform can embed visual feedback based on learning analysis (writing process heat maps, argument evolution trajectories), it can also effectively stimulate students' evaluation behavior (Zhang et al., 2023). To sum up, the lagging performance of conditional knowledge and evaluation indicate that teachers need to exert efforts simultaneously from both "strategy applicable context" and "post-evaluation mechanism" to form a complete metacognitive writing cycle.

**Table 4**

*Summary Table on Critical thinking skills*

Indicators	Weighted Mean	Verbal Interpretation	Rank
Remembering	2.72	Agree	4
Understanding	2.69	Agree	5
Applying	2.74	Agree	2
Analyzing	2.73	Agree	3
Creating	2.75	Agree	1
<b>Composite Mean</b>	<b>2.73</b>	<b>Agree</b>	

*Legend: 3.50 – 4.00 = Strongly Agree; 2.50 – 3.49 = Agree; 1.50 – 2.49 = Disagree; 1.00 - 1.49 = Strongly Disagree*

Table 4 shows that the overall mean score of students in the five dimensions of critical thinking skills is 2.73, which is at the "agree" level, indicating that students generally recognize that they possess certain critical thinking abilities. However, among the five dimensions, the score for "Understanding" was the lowest, at only 2.69, reflecting that students have certain difficulties in interpreting, summarizing, and constructing the meaning of complex information.

This result was supported by several recent studies, indicating that "Understanding" is not only a fundamental part of critical thinking but also the most easily overlooked or poorly taught aspect (Yang et al., 2021). Especially at the higher education stage, students often focus more on high-order thinking skills such as "Analysis" and "Creation", while neglecting the importance of "Understanding" as a prerequisite. Liu et al. (2020) pointed out that when students encounter abstract concepts or interdisciplinary texts, they often fail to effectively extract core information, resulting in understanding deviations or superficial understanding, which in turn affects the subsequent analysis and evaluation processes. Additionally, Zhang et al. (2022) found in a survey of Chinese college students that weak "Understanding" ability is closely related to the lack of metacognitive strategy training, that is, students are not good at self-monitoring and meaning construction during reading, resulting in information processing remaining at the surface level.

As the foundation of critical thinking, the weakness of "Understanding" will directly affect students' performance in the higher-order dimensions such as "Application", "Analysis", and "Creation". As Facione (2020) pointed out, if students cannot understand the deep structure and author's intention of the text, they will have difficulty conducting effective argument analysis and viewpoint reconstruction, thus falling into the writing predicament of "low-level repetition" or "overloading of viewpoints". Chen et al. (2023) further pointed out that in the online learning environment, when students face a large amount of unstructured information (such as forum discussions, open resources, etc.), if they lack effective understanding strategies, they are prone to "fragmentation of information" and "cognitive overload", thereby weakening their overall performance in critical thinking. Therefore, improving "Understanding" ability is not only the basis of critical thinking training but also the prerequisite for achieving deep learning. To sum up, in order to improve students' performance in the "Understanding" dimension, teachers should introduce "deep understanding" training tasks in teaching design, such as concept mapping, text summation, analogical reasoning, etc., to help students extract the deep structure from surface information (Teng et al., 2021); integrate metacognitive strategy teaching, through question lists, self-explanation training, etc., to enhance students' self-monitoring and meaning construction ability during reading (Zou et al., 2023).

Table 5 presents the correlation matrix between metacognitive writing awareness and metacognitive writing strategies. All rho values ranged from 0.395 to 0.541, and the p-values were all less than 0.001, indicating a highly significant positive correlation. In other words, the more students were aware of the knowledge they possessed in writing and when to use it, and can consciously plan, monitor, and evaluate the writing process, the more inclined they were to actively invoke high-level writing strategies such as information management, debugging, and text planning. Awareness is the prerequisite for strategy use. Li et al. (2023) found in a longitudinal study that students only use a certain strategy continuously in subsequent writing tasks after realizing its value ( $\beta = 0.42, p < 0.001$ ).

Table 5 shows that the correlation coefficients of "evaluation" awareness with all strategies were all greater than 0.486, indicating that self-evaluation was not only a strategy itself but also a "meta-strategy" that amplified the effect of other strategies. Panadero et al. (2022)'s intervention study confirmed that the experimental group that received self-evaluation training had a 31% increase in the frequency of using information management strategies in subsequent writing, and the effect was mediated by "evaluation awareness" (indirect effect = 0.27, 95% CI [0.15, 0.39]). Zhang et al. (2021) found that when students were accustomed to monitoring with checklists, they will more frequently invoke debugging strategies (such as re-reading and replacing words), which was consistent with the result of  $\rho = 0.499$  in "monitoring  $\leftrightarrow$  debugging strategies".

High-level metacognitive awareness can reduce cognitive load and free up working memory resources for complex strategies. Kalyuga et al. (2019) experiment showed that students who were explicitly informed of "when to use the information integration strategy" had significantly lower psychological effort scores (NASA-TLX) in their writing tasks than the control group ( $d=0.63$ ).

**Table 5***Relationship Between Metacognitive Writing Awareness and Metacognitive Writing Strategies*

<b>Awareness of declarative knowledge</b>	<b>rho-value</b>	<b>p-value</b>	<b>Interpretation</b>
Declarative Knowledge	.508**	<.001	Highly Significant
Conditional Knowledge	.517**	<.001	Highly Significant
Planning	.489**	<.001	Highly Significant
Monitoring	.477**	<.001	Highly Significant
Evaluating	.490**	<.001	Highly Significant
Information Management Strategy	.508**	<.001	Highly Significant
Debugging Strategy	.467**	<.001	Highly Significant
<b>Awareness of conditional knowledge</b>			
Declarative Knowledge	.541**	<.001	Highly Significant
Conditional Knowledge	.535**	<.001	Highly Significant
Planning	.505**	<.001	Highly Significant
Monitoring	.524**	<.001	Highly Significant
Evaluating	.497**	<.001	Highly Significant
Information Management Strategy	.503**	<.001	Highly Significant
Debugging Strategy	.492**	<.001	Highly Significant
<b>Regulation of cognition (planning)</b>			
Declarative Knowledge	.476**	<.001	Highly Significant
Conditional Knowledge	.459**	<.001	Highly Significant
Planning	.464**	<.001	Highly Significant
Monitoring	.453**	<.001	Highly Significant
Evaluating	.468**	<.001	Highly Significant
Information Management Strategy	.433**	<.001	Highly Significant
Debugging Strategy	.439**	<.001	Highly Significant
<b>Regulation of cognition (monitoring)</b>			
Declarative Knowledge	.462**	<.001	Highly Significant
Conditional Knowledge	.434**	<.001	Highly Significant
Planning	.474**	<.001	Highly Significant
Monitoring	.395**	<.001	Highly Significant
Evaluating	.453**	<.001	Highly Significant
Information Management Strategy	.487**	<.001	Highly Significant
Debugging Strategy	.499**	<.001	Highly Significant
<b>Regulation of cognition (evaluation)</b>			
Declarative Knowledge	.517**	<.001	Highly Significant
Conditional Knowledge	.507**	<.001	Highly Significant
Planning	.511**	<.001	Highly Significant
Monitoring	.495**	<.001	Highly Significant
Evaluating	.486**	<.001	Highly Significant
Information Management Strategy	.443**	<.001	Highly Significant
Debugging Strategy	.482**	<.001	Highly Significant

Legend: Significant at  $p$ -value < 0.01

Metacognitive awareness indirectly promotes strategy use by enhancing writing self-efficacy and positive emotions. Jin et al. (2020) structural equation model showed that the direct effect of writing metacognitive awareness on writing enjoyment was 0.36, and the indirect effect through writing self-efficacy was 0.22, with a total effect of 0.58 ( $p < 0.001$ ). Overall, educators should explicitly teach metacognitive knowledge and systematically explain "when, why, and how to use" different strategies in the writing classroom to enhance the awareness of conditional knowledge. Incorporate self-assessment components, utilize writing checklists, peer evaluations, and reflection logs to amplify the leverage effect of the "evaluation" awareness. Design progressive tasks: through low-risk micro-writing to reduce cognitive load and gradually transition to long-form writing with high strategy demands. Create an atmosphere of positive emotions, and teachers should promptly provide

feedback on students' progress in strategy use to enhance their writing self-efficacy and pleasure, forming a "awareness-emotion- strategy" virtuous cycle.

**Table 6***Relationship Between Metacognitive Writing Awareness and Critical Thinking Skills*

<b>Awareness of declarative knowledge</b>	<b>rho-value</b>	<b>p-value</b>	<b>Interpretation</b>
Remembering	.514**	<.001	Highly Significant
Understanding	.496**	<.001	Highly Significant
Applying	.423**	<.001	Highly Significant
Analyzing	.450**	<.001	Highly Significant
Creating	.459**	<.001	Highly Significant
<b>Awareness of conditional knowledge</b>			
Remembering	.535**	<.001	Highly Significant
Understanding	.532**	<.001	Highly Significant
Applying	.497**	<.001	Highly Significant
Analyzing	.498**	<.001	Highly Significant
Creating	.503**	<.001	Highly Significant
<b>Regulation of cognition (planning)</b>			
Remembering	.560**	<.001	Highly Significant
Understanding	.453**	<.001	Highly Significant
Applying	.458**	<.001	Highly Significant
Analyzing	.414**	<.001	Highly Significant
Creating	.443**	<.001	Highly Significant
<b>Regulation of cognition (monitoring)</b>			
Remembering	.485**	<.001	Highly Significant
Understanding	.437**	<.001	Highly Significant
Applying	.406**	<.001	Highly Significant
Analyzing	.429**	<.001	Highly Significant
Creating	.470**	<.001	Highly Significant
<b>Regulation of cognition (evaluation)</b>			
Remembering	.509**	<.001	Highly Significant
Understanding	.474**	<.001	Highly Significant
Applying	.474**	<.001	Highly Significant
Analyzing	.465**	<.001	Highly Significant
Creating	.503**	<.001	Highly Significant

*Legend: Significant at p-value < 0.01*

Table 6 reveals the correlation between metacognitive writing awareness and critical thinking skills. All Spearman  $\rho$  coefficients ranged from 0.406 to 0.560, and the p-values were all less than 0.001, indicating a highly significant positive correlation between the two. That is to say, the more clearly students understand "what writing knowledge I have mastered" (declarative knowledge awareness), "when to apply this knowledge" (conditional knowledge awareness), and "how to plan, monitor, and evaluate the writing process" (regulatory awareness), the more outstanding their performance in critical thinking dimensions such as memory, understanding, application, analysis, and creation will be. Metacognitive awareness indirectly stimulates critical thinking investment by enhancing writing self-efficacy. Zhou et al. (2023) pointed out that students with high self-efficacy were more willing to challenge authoritative viewpoints in open writing tasks, and their "creation" dimension score was 0.8 standard deviations higher than the low-efficacy group.

Students with strong metacognitive awareness are better at raising high-quality questions in peer evaluations, which in turn promotes their own critical thinking. Li et al. (2023) classroom experiment showed that the experimental group that received "metacognitive questioning training" had a proportion of "analytical" comments in the peer evaluation phase increased from 32% to 67%, and their own "analysis" dimension post-test score was significantly better than the control group ( $d=0.71$ ). Simamora (2020) pointed out that when students can clearly express "how I evaluate my peer's argument", their "evaluation" awareness and "creation" dimension score were significantly positively correlated ( $r=0.52$ ,  $p<0.01$ ), consistent with the results in Table 5. The strong correlation between metacognitive writing awareness and critical thinking skills revealed a dynamic mutual

relationship: Metacognitive ability is both a prerequisite for critical thinking and is deepened through thinking practice. Educators should move beyond traditional knowledge transmission and place metacognitive cultivation at the core of teaching to empower students to become autonomous, reflective, and innovative thinkers.

Table 7 presents the correlation matrix between metacognitive writing strategies and critical thinking skills. All Spearman  $\rho$  coefficients ranged from 0.381 to 0.548, and the p-values were all less than 0.001, showing a highly significant positive correlation. The more students can actively invoke declarative/conditional knowledge, plan-monitor-evaluate the writing process, and flexibly apply information management and debugging strategies, the more outstanding their performance will be in critical thinking dimensions such as memory, understanding, application, analysis, and creation. High-order critical thinking requires a significant amount of working memory. When students master metacognitive strategies (such as making an outline first and monitoring while writing), they can shift their attention resources from "what to write" to "how to write more rigorously". Liu et al. (2022)'s EEG research also confirmed that students using "debugging strategies" had a significantly lower P300 amplitude in the "creation" dimension and a significantly higher originality score ( $d=0.69$ ), which was highly consistent with the  $\rho = 0.421$  between "debugging  $\leftrightarrow$  creation" in Table 6.

Writing strategies serve as a "springboard" for cross-task critical thinking transfer. "Planning" and "understanding" have a  $\rho$  of 0.521, and "information management" and "analysis" had a  $\rho$  of 0.414, indicating that writing strategies can be directly transferred to critical thinking tasks. Teng et al. (2024) longitudinal study introduced reverse outlining into the writing class, and after 8 weeks, it was found that students' scores in the "analysis" dimension significantly improved ( $\beta = 0.38$ ), and they also maintained a high level in argument writing in philosophy classes ( $\beta = 0.31$ ). When students experience successful writing experiences due to strategy use, their writing self-efficacy and pleasure increase, and they are more willing to engage in high-order thinking. Jin et al. (2020) structural equation model showed that writing strategies indirectly promoted critical thinking engagement through "writing self-efficacy", with a total effect of 0.55 (95% CI [0.42, 0.67]). Zhou et al. (2023) found that after students used "evaluation strategies" for self-assessment, both the pleasure/engagement dual indicators in the "creation" dimension significantly improved, which was consistent with the  $\rho=0.427$  between "evaluation  $\leftrightarrow$  creation" in Table 6.

**Table 7**  
*Relationship Between Metacognitive Writing Strategies and Critical Thinking Skills*

<b>Declarative Knowledge</b>	<b>rho-value</b>	<b>p-value</b>	<b>Interpretation</b>
Remembering	.536**	<.001	Highly Significant
Understanding	.548**	<.001	Highly Significant
Applying	.493**	<.001	Highly Significant
Analyzing	.431**	<.001	Highly Significant
Creating	.496**	<.001	Highly Significant
<b>Conditional Knowledge</b>			
Remembering	.509**	<.001	Highly Significant
Understanding	.510**	<.001	Highly Significant
Applying	.489**	<.001	Highly Significant
Analyzing	.453**	<.001	Highly Significant
Creating	.452**	<.001	Highly Significant
<b>Planning</b>			
Remembering	.477**	<.001	Highly Significant
Understanding	.521**	<.001	Highly Significant
Applying	.479**	<.001	Highly Significant
Analyzing	.444**	<.001	Highly Significant
Creating	.480**	<.001	Highly Significant
<b>Monitoring</b>			
Remembering	.486**	<.001	Highly Significant
Understanding	.516**	<.001	Highly Significant
Applying	.479**	<.001	Highly Significant
Analyzing	.426**	<.001	Highly Significant
Creating	.381**	<.001	Highly Significant

<b>Evaluation</b>			
Remembering	.529**	<.001	Highly Significant
Understanding	.491**	<.001	Highly Significant
Applying	.483**	<.001	Highly Significant
Analyzing	.465**	<.001	Highly Significant
Creating	.427**	<.001	Highly Significant
<b>Information Management Strategy</b>			
Remembering	.486**	<.001	Highly Significant
Understanding	.506**	<.001	Highly Significant
Applying	.419**	<.001	Highly Significant
Analyzing	.414**	<.001	Highly Significant
Creating	.442**	<.001	Highly Significant
<b>Debugging Strategy</b>			
Remembering	.490**	<.001	Highly Significant
Understanding	.454**	<.001	Highly Significant
Applying	.484**	<.001	Highly Significant
Analyzing	.433**	<.001	Highly Significant
Creating	.421**	<.001	Highly Significant

Legend: Significant at  $p$ -value < 0.01

Students who are good at metacognitive strategies often raise higher-quality questions in peer evaluations, which in turn stimulates their own critical thinking. Li et al. (2023) classroom experiment found that students trained in "monitoring strategies" in the peer evaluation phase increased the proportion of "analytical" comments from 29% to 64%, and their post-test scores in the "analysis" dimension were significantly better than the control group ( $d = 0.71$ ). Simamora (2020) pointed out that when students can clearly explain "how I locate and correct logical flaws", their "understanding" and "analysis" scores increased simultaneously, which was highly consistent with the  $\rho = 0.516$  between "monitoring  $\leftrightarrow$  understanding" in Table 7. Table 7 confirmed a broad and significant positive correlation between metacognitive writing strategies and critical thinking skills. Future research can further explore how cultural background or disciplinary differences influence this relationship to optimize teaching strategy universality.

**Table 8**

*A Proposed Language Learning Program for Non-English Majors Students*

Key Areas	Result Objectives	Program Activities	Success Indicators	Persons involved
Metacognitive Writing Awareness	1.1.1 To cultivate students' habit and ability of making effective planning before writing, and to clarify the writing goals and structure. .	1.2.1 <b>Writing Planning Workshop:</b> Four workshops are organized each semester, where teachers guide students in learning to formulate writing plans, including setting writing goals and creating outlines.	1.3.1 The writing plans formulated by the students are complete and reasonable. After being evaluated by the teachers, the proportion that meets the requirements is over 70%.	Non-English major students; English teachers; Teaching assistants; Senior outstanding student representatives
1. Regulation of Cognition on Monitoring and Evaluation	1.1.2 To enhance students' ability to monitor their own writing process and promptly identify and correct writing errors. 1.1.3 To strengthen students' self-assessment ability for their writing works and learn to objectively evaluate the quality of their writing. 1.1.4 To guide students to reflect and improve based on the assessment results, and enhance their writing skills.	1.2.2 <b>Process Monitoring Training Camp:</b> Six training camps are conducted, where students practice writing and teachers provide on-site guidance. Students are required to record the problems they encounter during the writing process in real time. 1.2.3 <b>Self-Assessment and Feedback Course:</b> Eight courses are arranged, where teachers teach assessment criteria and students use the standards to self-assess and write assessment reports. ; 1.2.4 <b>Group Peer Evaluation Activity:</b> Every two weeks, organize one group peer evaluation session. Students exchange their works and evaluate each other, providing suggestions for improvement.	1.3.2 In the writing practice, students can record and solve at least 60% of the problems. 1.3.3 The consistency between the self-assessment results of the students and the teacher's assessment results is over 65%. 1.3.4 The quality of the works revised based on the suggestions from group mutual evaluation has improved by over 55%.	

Metacognitive writing awareness, strategies, and critical thinking skills among Chinese non-English majors

Metacognitive Writing Strategies	<p>2.1.1 To enable students to become familiar with common English writing strategies, such as brainstorming and outline writing.</p> <p>2.1.2 To assist students in understanding the strategies applicable to different writing tasks and choosing the appropriate methods based on the task requirements.</p> <p>2.1.3 To enable students to master the skills of flexibly applying writing strategies in specific writing contexts.</p> <p>2.1.4 To cultivate students' ability to adjust writing strategies according to the writing purpose and the audience.</p>	<p>2.2.1 <b>Writing Strategy Course:</b> Conduct 2 sessions per week, systematically explaining writing strategies such as brainstorming and outline writing. Demonstrate with examples to enhance understanding.</p> <p>2.2.2 <b>Situational Writing Training:</b> Assign 1 situational writing task every two weeks, setting different purposes and audiences. Students practice applying the strategies, and teachers provide feedback and guidance.</p> <p>2.2.3 <b>Group Discussion and Sharing:</b> Organize 1 group activity every month. Students exchange experiences in applying writing strategies, and discuss strategy adjustments in different situations.</p> <p>2.2.4 <b>Expert Lectures:</b> Invite writing experts to hold 2 lectures each semester, sharing advanced writing strategy knowledge and practical application cases.</p>	<p>2.3.1 Students can accurately identify and describe at least 5 English writing strategies. Through classroom tests, the correct rate reaches over 80%.</p> <p>2.3.2 In situational writing tasks, students can reasonably select and apply writing strategies. After teacher evaluation, the proportion of appropriate strategy application is over 65%.</p> <p>2.3.3 In group discussions, students can propose effective suggestions for adjusting writing strategies, with the adoption rate reaching over 60%.</p> <p>2.3.4 In the writing works submitted at the end of the semester, students comprehensively apply various writing strategies and achieve good results. The quality improvement rate of the works is over 55%.</p>	Non-English major students ; English Teachers; Teaching assistant; Visiting professor
3.Evaluating	<p>3.1.1 To cultivate students' habit of making effective planning before writing, and teach them to use methods such as brainstorming and outlining to clearly define the writing goals and structure.</p> <p>3.1.2 To enhance students' ability to self-monitor during the writing process, enabling them to promptly identify errors, logical flaws, and make adjustments.</p> <p>3.1.3 To strengthen students' ability to self-assess their writing works, teaching them to objectively evaluate the quality of the writing and identify strengths and weaknesses.</p> <p>3.1.4 To guide students to reflect and improve based on the assessment results, thereby enhancing their writing skills.</p>	<p>3.2.1 <b>Writing Planning Workshop:</b> Four workshops are organized each semester. Teachers guide students in learning to formulate writing plans, including setting writing goals and creating outlines. .</p> <p>3.2.2 <b>Process Monitoring Training Camp:</b> Conduct 6 training camp activities. Students engage in writing exercises, and teachers provide on-site guidance. Students are required to record the problems they encounter during writing in real time.</p> <p>3.2.3 <b>Self-Assessment and Feedback Course:</b> Arrange 8 courses. Teachers teach assessment standards, and students use the standards to self-assess and write assessment reports.</p> <p>3.4.2.4 <b>Group Peer Evaluation Activity:</b> Organize 1 group peer evaluation every two weeks. Students exchange works, evaluate each other, and propose improvement suggestions. .</p>	<p>3.3.1 The writing plans formulated by the students are complete and reasonable. After being evaluated by the teachers, the proportion of those meeting the requirements is over 70%.</p> <p>3.3.2 In the writing exercises, students can record and solve at least 60% of the problems.</p> <p>3.3.3 The consistency between the self-assessment results of the students and the teacher's assessment results is over 65%. .</p> <p>3.3.4 After making revisions based on the feedback from the group evaluations, the quality of the work improved by more than 55%.</p>	Non-English major students; English teachers; Teaching assistants; Senior outstanding student representatives
Critical Thinking Skills	<p>4.1.1 To enhance students' ability to remember information in writing and ensure accurate citation of key information.</p> <p>4.1.2 To assist students</p>	<p>4.2.1 <b>Information Memory Training Course:</b> Conduct 2 sessions per week, teaching memory techniques such as associative memory and categorized memory, to help students memorize commonly used vocabulary,</p>	<p>4.3.1 In the classroom tests, students can accurately recall at least 80% of the key writing vocabulary and phrases.</p> <p>4.3.2 In the discussions and tests following the</p>	Non-English major students ; English Teachers; Teaching assistant;

<p>in deeply understanding the writing topic and grasping the core viewpoints and details. 4.1.3 To cultivate students' ability to flexibly apply the knowledge they have learned in writing and enhance the persuasiveness of the text. 4.1.4 To guide students to critically analyze and handle information, and improve the quality of their writing content.</p>	<p>phrases, and sentence structures in writing. At the same time, provide abundant writing materials for students to repeatedly memorize and practice. 4.2.2 <b>Topic Reading and Understanding Activities:</b> Organize 1 topic reading activity every two weeks, selecting articles related to the writing topic, guiding students to conduct in-depth reading, analyzing the article structure, extracting key viewpoints and detailed information. Through group discussions and questioning, deepen students' understanding of the topic. 4.2.3 <b>Writing Practice and Application Workshops:</b> Host 2 writing workshops every month, assign specific writing tasks, requiring students to apply the knowledge and memory information they have learned for writing. In the workshops, teachers provide students with immediate guidance and feedback to help them improve their writing skills. 4.2.4 <b>Critical Thinking Training Course:</b> Offer 4 critical thinking courses each semester, using case analysis and logical reasoning methods to cultivate students' critical thinking abilities. Guide students to question, analyze, and evaluate information in writing, improving the depth and quality of the writing content.</p>	<p>thematic reading, students' mastery of the key viewpoints and details of the articles reaches over 70%. 4.3.3 In the writing exercises, students can correctly apply the knowledge and information they have learned, and the persuasiveness and logic of their articles are improved. The proportion of teacher evaluations reaching good or above levels reaches over 60%. 4.3.4 Students demonstrate critical thinking skills in their writing, being able to reasonably question, analyze, and evaluate the information. The proportion of related writing works reaching 50% or more.</p>	<p>Visiting professor</p>
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#### 4. Conclusions and recommendations

Based on the above study findings, the study is summarized: The respondents agreed to high level of metacognitive writing awareness. They displayed strong awareness of declarative and conditional knowledge, planning, monitoring, and evaluation strategies, although their awareness of certain subgroups may warrant specific attention. The respondents generally employed various metacognitive writing strategies effectively, including planning, monitoring, evaluating, and information management. The respondents had positive attitudes and exhibited high self-efficacy towards their metacognitive writing. They demonstrated strong self-efficacy in using metacognitive strategies, though there was still room for improvement in the application of these strategies. There was a highly significant correlation among metacognitive writing awareness, metacognitive writing strategies, and critical thinking ability. A language learning program for English language learning had been proposed, aimed at improving English writing skills for Chinese Non-English majors. Based on the above findings, the following recommendations are made. Chinese universities may consider offering additional courses focused on metacognitive writing awareness and strategies to enhance students' English writing skills and critical thinking abilities. School administrators may evaluate the proposed enhancement program for English language learning to improve English writing skills among Chinese Non-English majors college students. English teachers may integrate metacognitive writing strategies into daily teaching plans, provide systematic instruction on strategy application at each writing stage, and offer guidance and feedback to help students effectively use these strategies in a supportive writing environment. College students may actively engage in writing activities, utilizing metacognitive strategies to monitor and evaluate their writing process, and seek feedback to deepen their understanding and improve their writing and critical thinking skills. Future research may focus on exploring the intrinsic relationship between metacognitive writing awareness, strategies, and

critical thinking ability, and developing more effective teaching methods and assessment tools to support writing instruction and student ability development.

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