

The Impact of AI Writing Feedback Tools on the Metacognitive Abilities of English Major Students: An Empirical Study Based on Self-Regulated Learning

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Abstract: In the context of digital education, academic writing instruction for English majors faces practical challenges such as students' weak metacognitive abilities and insufficient self-regulation skills, making traditional writing feedback models inadequate for fostering higher-order academic competencies. Grounded in self-regulated learning theory, this study integrates AI-powered writing feedback tools into English academic writing training, establishing cognitive scaffolding and cyclical reflection mechanisms to optimize the professional writing training framework. Through empirical investigation conducted in accordance with academic writing textbook standards, the study demonstrates that intelligent feedback effectively mitigates writing-related cognitive biases and comprehensively enhances both metacognitive abilities and self-regulation skills among English majors.

Keywords: AI writing feedback tool; English major; Academic writing; Metacognition; Self-regulated learning

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1. Introduction: Why focus on AI writing feedback tools and metacognitive development

In the context of digital education transformation, English academic writing has become crucial for cultivating core competencies in English majors, with metacognitive proficiency determining the overall quality of academic writing. Leveraging the principles of self-regulated learning, intelligent AI writing feedback tools enable multidimensional and precise assessment of academic writing. By harnessing intelligent technologies to transform writing instruction and exploring the relationship between intelligent feedback and metacognitive elements, these tools address the limitations of traditional written grading, providing new perspectives and theoretical support for developing academic writing skills in English majors. Establishing an academic writing curriculum within undergraduate English programs to systematize the cultivation of writing abilities and achieve educational objectives warrants further exploration.

2. Key principles of self-regulated learning theory and its educational value in English writing

2.1. Self-monitoring and regulation: The core support for metacognitive development

Self-monitoring and self-regulation within the self-regulated learning framework serve as the core intrinsic element bridging academic writing for English majors with metacognitive literacy development, aligning seamlessly with the innovative educational philosophy of foreign language disciplines in the digital era^[1]. This mechanism permeates the entire academic writing process—from topic conception and resource integration to framework construction, linguistic expression, and standardized citation—enabling dynamic constraints and adjustments through continuous cognitive review. Aligned with standardized requirements of English academic writing, self-monitoring enhances textual logical coherence, defines normative expression standards, refines sentence structure control, and deepens understanding of academic writing paradigms, facilitating proactive identification of writing deficiencies, content gaps, and expressive deviations at the cognitive level. Routine cognitive monitoring strengthens the foundational architecture of metacognition, shifting writing cognition from passive task completion to proactive strategic planning. Through systematic cognitive management, it meets the rigorous and professional standards of English academic writing, laying a solid internal foundation for the steady advancement of higher-order metacognitive abilities.

2.2. Feedback, reflection, and internalization: The key logic for enhancing academic writing

Feedback-driven reflection and internalization represent a crucial extension of self-regulated learning theory, serving as the core logical framework that drives the enhancement of academic writing quality and the evolution of metacognitive processes in English majors—a development aligned with the innovative integration of smart education and foreign language writing instruction. Systematic writing feedback addresses key professional writing elements such as linguistic style, logical reasoning, literature citation, content comparative analysis, and causal exposition, establishing multi-tiered, refined cognitive benchmarks. Continuous feedback reception and deep cognitive reflection facilitate the transformation of external writing evaluations into internalized cognitive experiences, enabling comprehensive internalization of academic writing knowledge, expressive strategies, and normative awareness. Through feedback-driven cognitive restructuring, academic writing cognitive patterns are reshaped, strengthening the closed-loop process of problem review, strategy optimization, and thinking refinement while continuously refining metacognitive reflection mechanisms. This approach promotes synergistic and progressive development of both comprehensive English academic writing competence and self-regulated cognitive abilities^[2].

3. The real challenges faced by English major students in academic writing metacognition

During the development of new liberal arts disciplines and the digital transformation of foreign language education, a prevalent issue emerges in academic writing for English majors: an imbalance in metacognitive development^[3]. The academic writing process lacks systematic cognitive planning, with insufficient continuous cognitive review and dynamic adjustment awareness at critical stages such as research topic selection, literature synthesis, outline construction, definition clarification, and argumentation expression.

Understanding of academic writing standards remains weak; there is inadequate proactive self-assessment regarding professional requirements like citation formatting, reference standards, and academic language style, making it difficult to accurately identify logical flaws and expressive deviations in texts. Traditional writing feedback mechanisms suffer from delayed responsiveness and limited dimensions, failing to provide comprehensive references for cognitive reflection and hindering thorough identification of writing issues. The cognitive internalization chain becomes disrupted, writing strategies remain rigid and singular, with insufficient proactive review and autonomous optimization of writing weaknesses. Consequently, self-regulatory learning mechanisms fail to function effectively, impeding simultaneous enhancement of metacognitive monitoring, reflection, and revision capabilities—and ultimately obstructing the standardized, sustainable development of academic writing proficiency in English majors.

4. Implementation pathways for enhancing metacognitive skills through AI writing feedback tools

4.1. Leveraging intelligent feedback to build personalized cognitive scaffolds

- (1) Hierarchical decomposition of writing modules, anchored in cognitive enhancement dimensions. Based on the complete workflow of English academic writing and utilizing AI-powered writing feedback tools, the content is modularly broken down. A detailed diagnostic analysis is conducted across core components including topic selection and conceptual framework, definition of concepts, resource utilization, textual structure, logical argumentation, linguistic expression, and citation standards ^[3]. In accordance with academic writing paradigms and professional requirements, implicit issues such as expressive inconsistencies, logical gaps, formatting deviations, and stylistic irregularities are systematically categorized and annotated at different levels. Concurrently, multi-dimensional validation is performed against the distinctive linguistic style, citation norms, and argumentation systems of English academic writing. Leveraging digital technology advantages, comprehensive writing challenges are decomposed into independent cognitive elements, enabling streamlined breakdown of complex writing tasks. This approach reduces cognitive load in academic writing, ensures precise metacognitive monitoring throughout the writing process, and progressively establishes a standardized, systematic cognitive framework for self-regulated learning. See **Figure 1** ^[4].

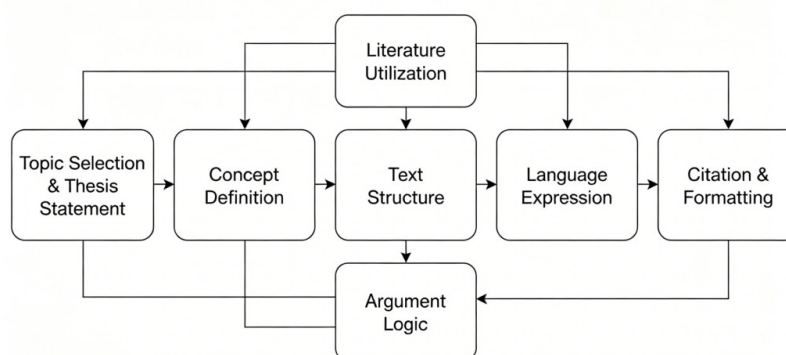


Figure 1. The Whole Process of English Academic Writing.

- (2) Match differentiated feedback content to establish dynamic cognitive support

Aligned with the academic writing objectives for third-year English majors, the AI writing feedback tool generates tailored revision guidance and cognitive prompts based on text quality and identified cognitive weaknesses, overcoming the limitations of traditional single-dimensional evaluation models. For diverse writing genres—including definitional essays, comparative analyses, causal investigations, and literature reviews—the tool provides targeted optimization recommendations, clarifying the internal logical structure, content expansion strategies, and standardized expression requirements of academic texts. In compliance with mainstream citation formats like APA and MLA, it intelligently verifies reference formatting, citation accuracy, and academic integrity compliance, enhancing cognitive mastery of scholarly norms. Through phased dynamic feedback, the system continuously addresses cognitive gaps, progressively refines writing methodologies, and fosters deep integration between external intelligent support and intrinsic cognitive development. This approach strengthens autonomous judgment, problem identification, and cognitive adjustment capabilities, solidifying the foundation for metacognitive development within self-regulated learning frameworks ^[5].

4.2. Establishing a cyclical reflection model to enhance self-regulated learning

- (1) Integrate intelligent feedback to trace the root causes of writing issues. Leveraging the comprehensive diagnostic insights from AI-powered writing feedback and aligning with English academic writing standards, conduct a step-by-step analysis of core challenges—including logical structure, conceptual definition, sentence construction, and argumentation techniques—during the text composition process. By incorporating professional requirements such as academic writing frameworks, source integration, and language style mastery, systematically identify cognitive biases in writing practices and clarify the intrinsic connections between conceptual gaps and writing errors. Using intelligent feedback as a reference, perform an in-depth review of cognitive aspects in writing, identify key academic writing norms and weak cognitive areas, and shift focus from superficial revisions to addressing deep-level cognitive issues, thereby laying the foundation for effective self-regulated learning ^[6].
- (2) Through collaborative revision and iteration, refine the cognitive correction mechanism by using the optimization directions provided by AI feedback as the benchmark. Focus on key writing elements such as academic paper citation standards, content comparative analysis, causal argumentation, and textual coherence to iteratively improve the text [7]. Strictly adhere to English academic writing conventions by adjusting text structure, optimizing expressions, and correcting formatting standards, thereby deepening the understanding and application of academic writing rules through continuous revision. Multiple rounds of text refinement establish a coherent cognitive correction chain, progressively correcting entrenched writing mindsets and expression habits, fostering proactive self-regulation during the writing process, and advancing cognitive correction in tandem with writing practice to enhance the self-regulatory mechanism.
- (3) Accumulate cognitive experience and establish a sustainable reflective framework. Integrate intelligent feedback and cognitive refinement insights gained from multiple rounds of writing revisions, summarize the creative logic, standardized norms, and strategic approaches for various academic writing genres, and build a systematic cognitive repository. Aligned with the internalization needs of academic writing development, incorporate phased reflective outcomes into daily writing practice to facilitate the transformation and consolidation of social discourse expression into intrinsic cognitive thinking. Guided by digital learning principles, institutionalize a regular reflective process to create a closed-loop system

connecting writing practice, intelligent feedback, cognitive reflection, and strategy optimization. This continuously enhances comprehensive competencies in cognitive planning, monitoring, and adjustment, thereby solidifying a sustainable mechanism for metacognitive development ^[8].

4.3. Integrating digital tools to optimize English academic writing training

- (1) A streamlined writing workflow integrates comprehensive cognitive training through an AI-powered writing feedback system that covers the entire academic writing process—from topic conception and literature review to outline development, body composition, and reference compilation—aligning with the standardized training framework for English majors. Digital intelligent analysis permeates core writing modules including definition elaboration, causal argumentation, comparative analysis, and discourse cohesion, while conducting continuous validation against academic language standards and citation requirements. Leveraging real-time assessment capabilities of digital tools, the system ensures seamless integration between initial planning, mid-process execution, and final refinement. Metacognitive monitoring is incorporated into every writing step, utilizing procedural digital controls to standardize academic writing practices and enhance cognitive oversight and rhythmic pacing throughout the entire process ^[9].
- (2) Grounded in academic standards, this program strengthens professional writing literacy by integrating the universal framework of English academic writing. Utilizing digital tools, it provides targeted training in citation formatting, bibliographic documentation, plagiarism avoidance, and academic language expression, aligning with mainstream formats such as APA, MLA, and Chicago. The curriculum focuses on common pitfalls in academic writing, offering intelligent detection and guided correction for plagiarism boundaries, paraphrasing logic, and review writing paradigms, thereby reinforcing understanding of academic integrity. Leveraging digital standard screening tools, it refines training modules covering language style refinement, professional terminology usage, and paragraph structure optimization. This approach gradually eliminates non-academic expression tendencies, establishes a writing framework tailored to English-language research requirements, and enhances the ability to adhere to standards within a self-regulated framework ^[10].
- (3) Internalize the connection theory and enhance independent writing training grounded in the philosophy of self-regulated learning development, this approach leverages the long-term recording and data retention capabilities of digital tools to preserve comprehensive writing and revision trails along with intelligent feedback, enabling traceability and review of the writing cognitive process. Aligned with the progression patterns of academic writing proficiency, it continuously cultivates professional skills such as argumentation and expression, abstract drafting, and standardized appendix handling, transforming external digital guidance into intrinsic writing thinking. Through regular digital writing practice, it overcomes the limitations of traditional training methods, fostering deep integration of writing strategies, cognitive reflection, and self-regulation while continuously optimizing metacognitive operations, thereby achieving coordinated advancement in both comprehensive English academic writing competence and autonomous learning capabilities ^[11].

5. Empirical study: Teaching application and outcomes of the AI writing feedback tool

5.1. Overall research design

Based on the content of the third-year “English Academic Paper Writing” course for English majors, the program is structured around the core writing modules covered in the textbook^[12]. Supported by self-regulated learning theory and metacognitive development principles, the research focus is defined. In alignment with the text types in the textbook, unified training content and feedback standards for academic writing are established. The AI writing feedback tool is integrated into the entire academic writing process, creating a systematic research framework that ensures the study aligns with the textbook content and training objectives of English academic writing instruction.

5.2. Teaching practice case study

Following the chapter structure of the textbook “English Academic Paper Writing”, regular writing practice is carried out around the textbook’s core topics, including research topic selection, data collection, cohesion and coherence, and argumentation. With emphasis on the textbook’s requirements for APA, MLA, and Chicago citation styles, quotation analysis, and academic anti-plagiarism standards, AI-based writing feedback tools are applied to textbook-specific training modules such as in-class paper writing, definition writing, cause-and-effect analysis, and comparison-and-contrast writing. In connection with the textbook’s specialized learning tasks, including research proposal writing, abstract composition, and reference compilation, intelligent feedback is used to support language error correction, sentence-level expression improvement, discourse structure adjustment, and academic formatting revision. Closely aligned with the textbook’s step-by-step requirements for academic writing throughout the whole process, students complete multiple rounds of revision, reflective review, and strategy adjustment, thereby forming a sustained teaching practice process that is well integrated with the textbook content^[13].

5.3. Research results and analysis

A multidimensional analysis is conducted in line with the textbook’s key assessment points, including citation discrimination, plagiarism avoidance, academic language style, figure and table conventions, and logical argumentation in academic papers. The sustained integration of AI writing feedback tools promotes cognitive monitoring throughout the entire academic writing process and across all textbook writing modules, thereby strengthening students’ in-depth understanding and application of academic conventions, textual structure, and discipline-appropriate expression presented in the textbook. Relying on the cyclical revision model enabled by intelligent feedback, students further internalize the textbook’s key and difficult components, such as definition writing, argumentative expression, and bibliographic documentation, while fostering a writing cognition model that aligns with the developmental requirements of self-regulated learning^[14]. Viewed from the perspective of performance across the full academic writing process, digital intelligent feedback can effectively connect the textbook’s theoretical content with writing practice, and continuously enhance metacognitive reflection as well as autonomous writing regulation mechanisms^[15].

6. Conclusion

This study explores the relationship between AI writing feedback tools and the metacognitive development

of English-major students. Drawing on the theory of self-regulated learning, it clarifies multiple pathways through which intelligent tools can empower academic writing instruction. The empirical findings show that digital intelligent feedback can improve the cognitive system involved in writing and strengthen learners' capacities for autonomous reflection and cognitive regulation. The study helps address the shortcomings of traditional writing instruction and provides practical reference for innovation in the teaching of English academic writing. Future research may further examine the integration of intelligent tools into foreign language teaching across a wider range of academic writing contexts.

Disclosure statement

The author declares no conflict of interest.

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