

Efficacy and Mechanism of Generative AI in Empowering English Writing Instruction

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Abstract

Generative artificial intelligence technology brings new transformative opportunities to English writing instruction. This paper analyzes the efficacy and mechanism of generative AI in empowering English writing teaching. Drawing on the Technology Acceptance Model and Self-Regulated Learning theory, it summarizes teaching efficacy from three dimensions—the quality of writing output, cognitive support during the writing process, and real-time adaptation of writing feedback—and further reveals the underlying mechanism through three layers: cognitive load reduction, learning motivation activation, and metacognitive strategy activation. Using data from a 12-week quasi-experimental study, it compares the experimental and control groups in terms of writing performance, writing strategy use, and feedback engagement. The results show that generative AI-assisted instruction has a moderately strong facilitative effect on learners' writing performance, achieved mainly by reducing extraneous cognitive load, enhancing writing self-efficacy, and deepening feedback engagement. This study provides theoretical grounding and practical reference for integrating generative AI into the English writing classroom.

Keywords

Generative Artificial Intelligence; English Writing Instruction; Teaching Efficacy; Mechanism of Action; Self-Regulated Learning

I. Introduction

With the rapid development of large language models exemplified by ChatGPT, generative artificial intelligence (GAI) is reshaping the forms and pathways of foreign language teaching. As a core skill of language output, English writing has long been plagued by delayed teacher feedback, insufficient individualized guidance, and prominent learner writing anxiety. Leveraging its capabilities in natural language generation, instant interaction, and multi-turn dialogue, generative AI offers new technical possibilities for addressing these difficulties. Existing research shows that AI-assisted writing feedback exhibits high accuracy and response speed in grammar correction, vocabulary optimization, and suggestions for textual

structure[1], and holds certain advantages over teacher feedback in surface-level linguistic correction[2].

Scholarly debate on generative AI's empowerment of writing instruction remains divided. Some studies find that AI feedback exerts a significant positive effect on learners' writing performance[3], while others caution that over-reliance on AI may weaken learners' critical thinking and independent writing ability[4]. Existing literature has largely focused on comparing the effects of AI and teacher feedback, lacking a systematic account of the internal mechanism through which generative AI empowers writing instruction—especially empirical investigations that integrate cognitive, motivational, and metacognitive processes within a unified analytical framework. Analyzing both the efficacy and the mechanism, and validating them with quasi-experimental data, can deepen understanding of the principles of English writing teaching in the digital-intelligence era.

II. Theoretical Foundations of Generative AI Empowering English Writing Instruction

(1) An Integrated Perspective of Technology Acceptance and Self-Regulated Learning

The Technology Acceptance Model holds that learners' perceived usefulness and perceived ease of use of a technology jointly determine their behavioral intention and actual use[5]. In the generative-AI writing classroom, learners' acceptance of AI tools directly affects the depth of their engagement and their learning outcomes. Self-Regulated Learning theory emphasizes that learners actively regulate their learning process through three phases—planning, monitoring, and reflection—with external feedback serving as the key stimulus that triggers the self-regulation cycle[6]. The instant, multi-turn feedback provided by generative AI creates conditions for learners' self-regulation, enabling them to continuously obtain information, adjust strategies, and evaluate progress throughout the writing process. Integrating technology acceptance with self-regulated learning can explain how learners develop their writing competence through AI tools.

(2) A Process View of Human-AI Collaborative Writing

The theory of human-AI collaborative writing regards AI as a collaborative partner rather than a replacement in the writing process, emphasizing that learners and AI jointly complete writing tasks through a cyclical interaction of prompting, evaluating, revising, and integrating[7]. This process view transcends the limitations of one-directional teacher feedback in traditional writing instruction, embedding feedback throughout the entire writing process—from pre-writing brainstorming and drafting in progress to post-writing revision, at each of which AI can provide differentiated support. Related reviews note that the application of generative AI in second-language writing exhibits stage-specific functional differentiation: the planning stage emphasizes inspiration generation, the drafting stage emphasizes

assistance with linguistic expression, and the revision stage emphasizes multi-dimensional evaluation and revision suggestions[8]. This process view of human-AI collaborative writing provides an analytical framework for understanding the teaching efficacy of generative AI.

III. The Efficacy of Generative AI in Empowering English Writing Instruction

(1) The Enhancing Effect on Writing Output Quality

The improvement of writing output quality by generative AI is first manifested in linguistic accuracy. A comparative analysis of 208 college English essays found that ChatGPT achieves high accuracy in grammar correction and punctuation revision, effectively correcting common errors such as tense, subject-verb agreement, and article use[1]. Meta-analytic research further indicates that the overall effect size of ChatGPT on EFL learners' writing skills is at a moderately strong level, with the improvement being particularly pronounced in writing instruction contexts[4]. At the lexical and syntactic levels, essays revised with AI assistance show greater lexical diversity and syntactic complexity, with significant increases in the proportion of academic vocabulary and syntactic variation[9]. However, AI's improvement of content depth and textual logic is relatively limited; raters observed smaller gains on the content and organization dimensions than on the language-use dimension[9], suggesting that the efficacy of generative AI has its boundaries.

(2) Cognitive Support during the Writing Process

During the writing process, generative AI provides learners with cognitive scaffolding through multi-turn dialogue. In the pre-writing stage, AI can dissect the writing topic from multiple perspectives and deliver differentiated materials and conceptual frameworks, alleviating learners' difficulty of having nothing to write; in the while-writing stage, AI can offer real-time suggestions on collocations, references for sentence transformations, and prompts for paragraph cohesion, helping learners break through expressive bottlenecks; in the post-writing stage, AI can provide comprehensive evaluation from dimensions such as content relevance, logical coherence, and linguistic appropriateness[10]. This full-process cognitive support transforms writing from an isolated individual endeavor into continuous human-AI interaction. Empirical research shows that AI-mediated collaborative writing environments can significantly enhance learners' writing engagement[11].

(3) Real-time Adaptation of Writing Feedback

Feedback is a core component of writing instruction. Traditional teacher feedback is often constrained by class size and grading cycles, making it difficult to achieve both immediacy and personalization simultaneously. Generative AI feedback breaks through these spatial and temporal limitations, generating revision suggestions within seconds after a learner submits a text, and supporting multiple rounds of follow-up and refinement on the same text[2]. In terms of content, AI can not only

identify linguistic errors but also explain their causes and provide alternative expressions; such explanatory feedback helps learners understand rules rather than mechanically revise[5]. In terms of adaptability, AI can adjust the level of detail and wording of feedback according to the learner's proficiency. Nevertheless, AI feedback tends to be programmatic and lacks the indirectness, richness, and individualized care characteristic of teacher feedback[6]; a hybrid human-AI collaborative feedback model may therefore be the preferable pedagogical choice.

IV. The Mechanism of Generative AI Empowering English Writing Instruction

(1) Cognitive Load Reduction and Reconstruction of Attentional Resources

Cognitive Load Theory holds that learners have limited working-memory capacity; when extraneous cognitive load is too high, the effective cognitive resources available for schema construction correspondingly decrease. In English writing, learners must simultaneously handle multiple tasks—lexical retrieval, grammatical encoding, content organization, and logical cohesion—and lower-proficiency learners often exhaust their attentional resources on expressive difficulties, leaving little capacity for content depth and textual structure. By instantly offering linguistic expression options, generative AI partially liberates learners from low-level lexical retrieval and grammatical monitoring, reducing extraneous cognitive load during writing and redirecting more attentional resources toward content planning and logical organization[12]. This mechanism explains why AI assistance is more effective for learners with weaker language foundations. However, if learners over-rely on AI-generated text and abandon active encoding, the result may be insufficient depth of linguistic processing, which is detrimental to long-term competence development.

(2) Motivation Activation and Enhancement of Self-Efficacy

Writing self-efficacy is an important motivational variable influencing learners' writing behavior and achievement. By lowering the threshold of writing, providing immediate positive feedback, and displaying visible progress trajectories, generative AI helps enhance learners' writing self-efficacy. Structural equation modeling studies show that learners' perceived ease of use, usefulness, and interactivity with generative AI jointly shape their behavioral intention, which in turn indirectly affects self-regulated learning ability through the mediating role of learning engagement[5]. Achievement goal orientation plays a moderating role between AI writing feedback and English writing self-efficacy: mastery-approach goal orientation amplifies the positive effect of AI feedback, whereas performance-approach goal orientation attenuates it[12]. Guiding learners to adopt mastery-approach goals and focus on the growth of their own writing ability helps maximize the motivational activation effect of AI.

(3) Activation of Metacognitive Strategies and Deepening of Feedback Engagement

Metacognitive strategies are the core component of self-regulated learning, comprising planning, monitoring, and evaluation. The multi-turn feedback mechanism of generative AI provides external scaffolding for activating metacognitive strategies: after submitting a draft, learners receive AI feedback and must evaluate its reasonableness, select the suggestions worth adopting, and execute revisions—this process is essentially monitoring and reflecting on one's own writing. Studies show that GenAI writing self-efficacy positively predicts the use of self-regulated writing strategies through the mediating role of feedback engagement[13]. Research on the effect of generative AI interventions on college students' foreign-language writing feedback engagement also finds that AI feedback significantly raises learners' engagement across three dimensions—feedback cognition, feedback behavior, and feedback emotion[5]. However, some learners tend to passively accept AI suggestions without critical evaluation; such superficial engagement limits metacognitive development[14]. Teachers therefore need to intervene and guide during the AI feedback process, cultivating learners' feedback literacy so that they can actively evaluate, filter, and utilize AI feedback, achieving a shift from passive acceptance to active regulation.

V. Empirical Analysis

(1) Research Design

To validate the above analysis of efficacy and mechanism, 68 students from two parallel college English classes at a university were selected as participants, comprising 34 in the experimental group and 34 in the control group. The experimental group incorporated generative AI assistance tools into a 12-week writing course, adopting a blended instructional model combining teacher guidance with AI feedback; the control group received conventional teacher-feedback instruction. An independent-samples t-test showed no significant difference between the two groups' English writing scores before the experiment ($p > 0.05$), confirming their comparability. The data included pre- and post-test writing scores (scored using the College English Test Band 6 writing rubric, with two independent raters; Pearson correlation = 0.87), a writing-strategy-use questionnaire, and a feedback-engagement scale; six students in the experimental group also participated in semi-structured interviews.

(2) Results and Analysis

The comparison of pre- and post-test writing scores is shown in Table 1. The experimental group's mean post-test score improved by 4.62 points over the pre-test, compared with 1.85 points for the control group; an independent-samples t-test revealed a significant difference in post-test scores between the two groups ($t = 3.21, p < 0.01$), with an effect size of Cohen's $d = 0.78$, a moderately strong effect. This result is broadly consistent with the effect-size range reported in meta-analytic research[4], indicating that generative AI-assisted instruction has a relatively stable

facilitative effect on writing performance.

Table 1. Comparison of Pre- and Post-test Writing Scores between the Experimental and Control Groups

Group	Pre-test (M±SD)	Post-test (M±SD)	Gain	t
Experimental (n=34)	11.35±2.18	15.97±2.34	4.62	3.21**
Control (n=34)	11.48±2.06	13.33±2.15	1.85	

Note: **p < 0.01; total score = 20.

With regard to writing strategy use, the experimental group used planning, monitoring, and revision strategies significantly more frequently than the control group at the post-test ($p < 0.05$), with the between-group difference for monitoring strategies being the most pronounced. This result supports the inference of a metacognitive-strategy activation mechanism. The comparison of feedback engagement is shown in Table 2: the experimental group scored higher than the control group on all three dimensions—feedback cognitive engagement, feedback behavioral engagement, and feedback emotional engagement—with the between-group difference in feedback behavioral engagement reaching significance ($t = 2.87$, $p < 0.01$).

Table 2. Comparison of Post-test Feedback Engagement Scores between the Experimental and Control Groups

Dimension	Experimental (M±SD)	Control (M±SD)	t
Feedback cognitive engagement	4.12±0.58	3.76±0.62	2.45*
Feedback behavioral engagement	4.28±0.51	3.65±0.68	2.87**
Feedback emotional engagement	3.95±0.64	3.68±0.59	1.83

Note: *p < 0.05, **p < 0.01; the scale uses a 5-point Likert rating.

To visualize the trajectory of the two groups' writing performance, the mean scores of four staged writing tests are plotted as a line chart (see Figure 1).

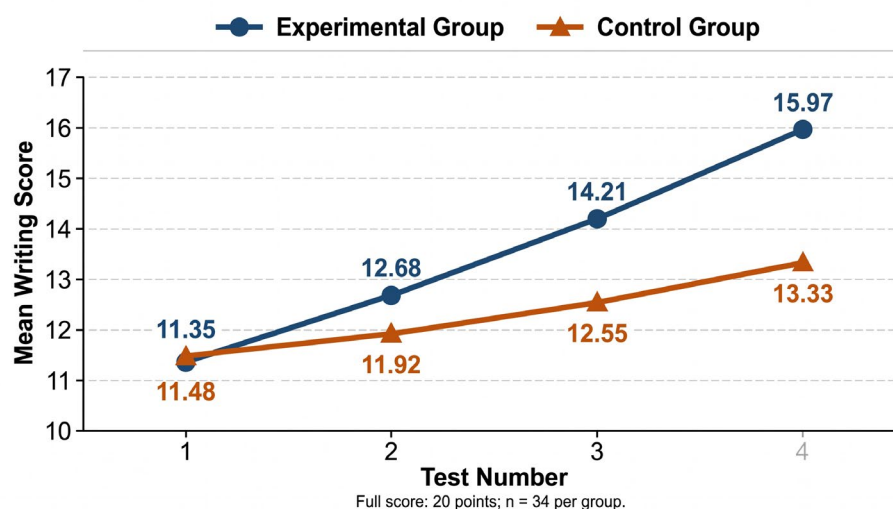


Figure 1. Trends in Mean Scores of the Four Writing Tests for the Experimental and Control

Groups

As shown in Figure 1, the two groups differed little in the first two tests; from the third test onward, the experimental group's advantage gradually widened, peaking by the fourth test. This trend is consistent with the findings of value-added studies, namely that the value-added benefit of blended teacher-AI feedback becomes increasingly evident as usage accumulates over time. The mechanism of generative AI in empowering English writing instruction can be summarized by the path model shown in Figure 2: the technical features of AI influence writing performance through three mediating paths—cognitive load reduction, motivation activation, and metacognitive activation—with learners' language proficiency and achievement goal orientation serving as moderating variables.

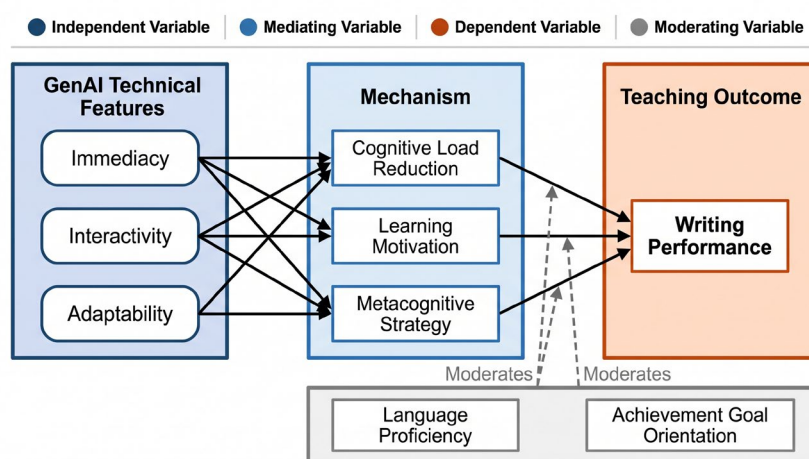


Figure 2. The Mechanism Model of Generative AI Empowering English Writing Instruction

VI. Discussion and Pedagogical Implications

The above analysis shows that the efficacy of generative AI in empowering English writing instruction is multi-dimensional, reflected not only in measurable improvements in writing output quality but also in cognitive support and feedback adaptation throughout the writing process. Its mechanism is not a single path but the coordinated operation of three layers—cognition, motivation, and metacognition. Cognitive load reduction frees up attentional resources; motivation activation sustains continued writing engagement; and metacognitive activation ensures that feedback is converted into deep learning. These three are interrelated and mutually reinforcing, together constituting the internal logic of generative AI's empowerment of writing instruction.

At the pedagogical level, first, a blended human-AI feedback model should be constructed. AI feedback has efficiency advantages in surface-level linguistic correction, whereas teacher feedback is irreplaceable in content guidance, emotional support, and individualized care; combining the two achieves

complementary strengths[2][6]. Teachers can rely on AI for basic grammar correction and vocabulary suggestions, concentrating their own effort on guiding content depth, textual logic, and writing strategies. Second, attention should be paid to cultivating learners' feedback literacy and competence in using AI, guiding them to critically evaluate the reasonableness of AI suggestions rather than passively accepting everything, while also teaching effective prompt-engineering skills[14]. Third, learners' individual differences should be attended to, with closer supervision and guidance of lower-proficiency learners during AI use to guard against over-reliance. Finally, a mastery-approach goal orientation should be fostered: through process-oriented evaluation that records learners' writing progress trajectories, their writing self-efficacy can be strengthened, so that AI technology truly serves competence development.

VII. Conclusion

Generative AI brings a significant empowerment effect to English writing instruction. Its efficacy manifests in three dimensions—improved writing output quality, cognitive support during the writing process, and real-time adaptation of writing feedback—while its mechanism is realized through the coordinated operation of three paths: cognitive load reduction, learning motivation activation, and metacognitive strategy activation. The quasi-experimental data show that the human-AI collaborative, AI-assisted instructional model has a moderately strong facilitative effect on learners' writing performance, and this effect accumulates over time. The pedagogical empowerment of generative AI has boundaries and conditions: its improvement of surface-level language exceeds that of content depth, its efficacy depends on learners' active feedback engagement and critical evaluation ability, and it is moderated by language proficiency and achievement goal orientation. Future research could enlarge the sample size and study duration and adopt longitudinal tracking designs to examine long-term effects, thereby providing more refined theoretical guidance and practical solutions for integrating generative AI into foreign-language writing instruction.

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