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From GenAI Use to L2 Writing Performance: A Moderated Sequential Mediation Model of Self-Efficacy and Metacognitive Strategy Use

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Abstract. Generative artificial intelligence is increasingly used to support second language writing; however, the motivational and strategic mechanisms linking GenAI use to L2 writing performance remain under-examined, particularly in exam-oriented contexts. Drawing on social cognitive theory and growth mindset theory, we tested a moderated sequential mediation model linking GenAI use to L2 writing performance through writing self-efficacy and metacognitive strategy use, with growth mindset moderating the relationship between GenAI use and self-efficacy. Survey data from 262 Chinese undergraduates who had completed the CET-4 were analyzed using partial least squares structural equation modeling (PLS-SEM) with 5,000 bootstrap resamples. The results showed that GenAI use was positively associated with self-efficacy, metacognitive strategy use, and L2 writing performance. Moreover, self-efficacy and metacognitive strategy use jointly mediated the relationship between GenAI use and writing performance, both independently and sequentially. Growth mindset further moderated the association between GenAI use and self-efficacy. These findings conceptualized GenAI as an environmental affordance that related to L2 writing outcomes through a motivational–strategic pathway, underscoring the importance of fostering growth-oriented beliefs and strategic regulation in GenAI-supported exam preparation.

Keywords: Generative artificial intelligence; growth mindset; L2 writing performance; metacognitive strategy use; self-efficacy

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1. Introduction

Writing is widely recognized as one of the most demanding skills in second language (L2) learning, requiring learners to integrate linguistic knowledge with sustained cycles of planning, monitoring, and revision (Bai & Guo, 2021; Hyland, 2019; Xu et al., 2025; Zimmerman & Bandura, 1994). In China, these challenges are intensified by the high-stakes, exam-oriented College English Test (CET-4), which prioritizes accuracy and time efficiency. However, limited access to timely, individualized feedback further constrains learners' opportunities to develop writing proficiency and sustain long-term motivation (Gao & Ma, 2022; Sheen, 2010).

The rapid emergence of generative artificial intelligence (GenAI) has begun to reshape L2 writing practices by offering immediate, adaptive feedback and scaffolding for idea development, linguistic refinement, and revision (Lee et al., 2025; Song & Song, 2023; Zheldibayeva, 2025). In this study, GenAI use includes using AI for feedback/correction, drafting support, and revision assistance. L2 writing performance (L2WP) is operationalized as task-based writing quality, indexed by linguistic accuracy, coherence/organization, and task achievement. Although prior studies suggest that GenAI can enhance writing quality and efficiency, concerns remain that uncritical reliance on AI-generated suggestions may reduce metacognitive engagement and hinder independent writing development (Barrot, 2023; Roa & Halim, 2024; Seddik, 2025). These mixed findings indicate that the effects of GenAI depend not only on technological affordances but also on learners' motivational and regulatory processes.

Social cognitive theory (SCT) and self-regulated learning (SRL) provide complementary lenses for understanding these processes. SCT highlights self-efficacy (SE) as a key motivational belief that shapes effort and persistence (Bandura, 1997, 2006). In this study, SE is modeled as a motivational mediator. Whereas SRL emphasizes metacognitive strategy use (MSU) as a central mechanism through which learners regulate writing (Pintrich, 1999; Zimmerman, 2000), which is modeled here as a strategic mediator. Growth mindset (GM) theory (Dweck, 2006, 2015) further explains individual differences in how learners interpret feedback and learning opportunities. Integrating these perspectives enables a more comprehensive understanding of how GenAI use relates to L2WP.

Importantly, SCT and SRL jointly suggest a directional relationship between SE and MSU: learners with stronger SE are more willing to invest effort in effortful regulatory processes, whereas low SE often suppresses the deployment of metacognitive strategies (Pajares, 2003; Zhang & Zhang, 2024; Zimmerman, 2000). Accordingly, we propose that GenAI uses influences L2WP indirectly through these psychological mechanisms. Specifically, SE and MSU are expected to mediate the relationship between GenAI use and L2WP, both independently (parallel mediation) and sequentially, such that GenAI use enhances SE, which in turn promotes MSU, ultimately leading to higher L2WP. Examining these mediation pathways is essential for clarifying how GenAI shapes L2 writing development.

GM, grounded in implicit theories of ability, provides a crucial boundary condition for these processes. Learners with a stronger GM view writing ability as malleable and tend to interpret feedback—human or AI-generated—as an opportunity for improvement (Dweck, 2006; Yu & Tao, 2025). Because GM influences how learners interpret feedback, it is likely to moderate the link between GenAI use and SE. Growth-oriented learners may perceive GenAI feedback as empowering and competence-enhancing, while fixed-mindset learners may engage with AI suggestions passively or interpret difficulties as evidence of limited ability. Prior research supports this moderating role, showing that GM shapes feedback interpretation, persistence, and willingness to engage in self-regulation (Burnette et al., 2013; Yeager & Dweck, 2012; Yin et al., 2025). GM may therefore determine whether GenAI strengthens or undermines the motivational mechanisms that support L2 writing.

Despite the explanatory value of SCT, SRL, and GM, prior GenAI-assisted L2 writing research has rarely (a) modeled the motivational–strategic mechanisms linking GenAI use to writing performance, (b) integrated SCT, SRL, and GM within a single explanatory framework, or (c) examined these processes in exam-oriented EFL contexts. To address these gaps, this study tests a moderated sequential mediation model in a CET-oriented EFL context, examining whether GenAI use relates to L2WP directly and indirectly through writing SE and MSU, with GM moderating the GenAI use–SE link. These aims are operationalized through five hypotheses (H1–H5) presented in the following section.

2. Literature Review

2.1 Theoretical Framework

SCT conceptualizes learning as the result of reciprocal interactions among environmental affordances, personal beliefs, and behavioral processes (Bandura, 1997). Within this framework, SE represents a central belief that shapes learners' effort, persistence, and performance. In GenAI-supported writing, GenAI functions as an environmental affordance that can influence learners' SE through repeated feedback and guided revision experiences (Bandura, 2006). Whereas SCT explains how learners' beliefs are formed through interactions with the learning environment, SRL theory specifies the regulatory processes through which these beliefs are enacted during writing (Pintrich, 2004; Zimmerman, 2000). SRL emphasizes learners' active control over learning through planning, monitoring, and evaluation (Zimmerman, 2000). In L2 writing contexts, such metacognitive strategies enable learners to translate motivational beliefs into effective writing behaviors and performance outcomes.

GMT (Dweck, 2006) further complements this framework by explaining individual differences in learners' interpretation of GenAI-generated feedback. Learners with a stronger growth mindset are more likely to view incremental improvements as evidence of learning rather than as external assistance, thereby amplifying gains in self-efficacy. Together, these perspectives constitute an integrated SCT–SRL–GMT framework, which proposes a motivational–strategic

mechanism through which GenAI use influences L2WP via SE and MSU, with GM shaping learners' motivational responses to AI-supported feedback (Bandura, 1997; Dweck, 2006; Zimmerman, 2000).

2.2 The Relationship between GenAI Use and L2WP

Unlike earlier automated writing evaluation (AWE) tools that mainly provide pre-scripted, error-focused feedback (e.g., grammar and mechanics), GenAI has been increasingly adopted as a support tool in L2 writing, offering interactive, context-sensitive assistance such as immediate feedback, linguistic reformulation, and task-specific scaffolding for idea development and revision (Lee et al., 2025; Liu et al., 2025). For L2 learners, writing often involves difficulties in idea development, organization, and linguistic accuracy, particularly under time constraints and performance pressure (Hyland, 2019; Kellogg, 2008). Prior research suggests that AI-supported writing environments can enhance textual quality by providing access to lexical and syntactic resources, offering model responses, and supporting iterative revision processes (Gayed et al., 2022; Song & Song, 2023).

By alleviating the cognitive demands associated with lower-level linguistic processing, GenAI may enable learners to allocate greater attentional resources to higher-order aspects of writing, such as coherence, organization, and argumentation (Feng, 2025). Consistent with this view, empirical studies have reported positive associations between AI-assisted writing and writing accuracy, fluency, and overall text quality, particularly when learners engage critically with AI-generated feedback rather than relying on AI output as a substitute for their own writing (Roa & Halim, 2024).

In exam-oriented contexts, such as CET preparation, where writing tasks are time-limited and accuracy-driven, GenAI can function as an accessible and personalized support resource, enabling learners to practice more efficiently and refine their performance. Despite some concerns about overreliance on AI (Barrot, 2023), existing evidence suggests that the use of GenAI can be positively associated with L2 writing outcomes, especially when integrated as a learning aid rather than a shortcut. Accordingly, this study proposes:

H1: GenAI use is positively associated with L2WP

2.3 The Mediating Role of SE between GenAI Use and L2WP

SE, defined as learners' beliefs in their capability to perform tasks successfully, is a central construct in SCT (Bandura, 1997) and a key motivational driver of effort, persistence, and self-regulated learning engagement (Pajares, 2003; Zimmerman, 2000). In L2 writing, learners with stronger writing SE are more willing to invest sustained effort, cope with difficulty, and engage in cognitively demanding writing processes, whereas those with lower SE are more likely to avoid challenges or disengage (Golparvar & Khafi, 2021; Sun & Wang, 2020).

Unlike traditional feedback sources, GenAI provides immediate, non-judgmental, and iterative responses that allow learners to clarify misunderstandings, test revisions, and observe incremental improvements in

their drafts (Lee et al., 2025). Such experiences may approximate mastery-related experiences—widely regarded as the most influential source of SE beliefs—thereby enhancing learners' confidence in managing writing tasks (Bandura, 1997; Usher & Pajares, 2008). Empirical studies on technology-mediated writing have similarly shown that interactive feedback environments can strengthen writing SE when learners actively engage with evaluative information (Bouzar et al., 2024; Zhang & Hyland, 2025).

From a motivational perspective, strengthened SE can subsequently translate into improved writing performance by promoting greater persistence, strategic engagement, and resilience in demanding writing conditions (Golparvar & Khafi, 2021). This pathway may be particularly salient in exam-oriented contexts such as CET preparation, where learners face time pressure and high-performance expectations, and where confidence in one's writing ability plays a crucial role in sustaining effort. Despite its theoretical relevance, however, prior research has rarely examined SE as a mechanism linking the use of GenAI to L2 writing outcomes. Accordingly, the present study proposes:

H2: SE mediates the relationship between GenAI use and L2WP

2.4 The Mediating Role of MSU between GenAI Use and L2WP

MSU refers to learners' deliberate regulation of their cognitive processes through planning, monitoring, and evaluation (Pintrich, 2000; Zimmerman, 2000). In L2 writing, MSU is particularly critical, as learners must organize ideas before writing, monitor linguistic and rhetorical accuracy during composition, and evaluate coherence and task fulfillment during revision (Ramadhanti & Yanda, 2021). Extensive research has demonstrated that effective metacognitive regulation is strongly associated with higher-quality writing outcomes (Kellogg, 2008; Teng & Yue, 2023; Zimmerman & Bandura, 1994).

GenAI-supported writing may facilitate MSU by providing continuous scaffolding across the writing process. Through interactive dialogue, GenAI can assist learners in generating outlines, identifying weaknesses, monitoring revisions, and evaluating alternative formulations (Liu et al., 2025). Importantly, because GenAI outputs are not infallible, learners must actively assess, adapt, and refine AI-generated suggestions rather than accept them uncritically (Barrot, 2023). Such evaluative engagement can strengthen learners' metacognitive monitoring and decision-making. In addition, effective interaction with GenAI often requires learners to refine prompts and clarify goals, which may further enhance metacognitive awareness and strategic regulation (Kasneci et al., 2023).
Taken together, these considerations suggest that GenAI use may influence L2WP by affecting learners' MSU. Accordingly, this study proposes:

H3: MSU mediates the relationship between GenAI use and L2WP

2.5 The Serial Mediating Role of SE and MSU

Within SCT and SRL frameworks, motivational beliefs and regulatory strategies are closely interconnected. SE shapes learners' perceptions of task difficulty and influences their willingness to invest effort in cognitively demanding regulation, whereas metacognitive strategies translate motivational readiness into practical

learning actions (Bandura, 1997; Zimmerman, 2000). Learners with higher SE are more likely to engage in planning, monitoring, and evaluation, while low SE often suppresses strategic regulation.

In GenAI-assisted writing, interactive feedback and guided revision may strengthen learners' SE by fostering confidence in managing writing tasks (Bandura, 1997, 2006). Heightened SE, in turn, may encourage learners to engage more strategically with GenAI—refining prompts, critically evaluating suggestions, and revising drafts—thereby enhancing metacognitive regulation (Pintrich, 2004; Zimmerman, 2000). This motivational–strategic sequence suggests a serial mechanism linking the use of GenAI to L2WP. Accordingly, we hypothesize:

H4: SE and MSU sequentially mediate the relationship between GenAI use and L2WP

2.6 The Moderating Role of GM

GM refers to the belief that abilities can be developed through effort, effective strategies, and learning experiences, whereas a fixed mindset views ability as relatively stable (Dweck, 2006). In educational and technology-supported learning contexts, GM shapes how learners interpret feedback, respond to challenges, and attribute success or failure, thereby influencing motivation and self-regulatory engagement (Burnette et al., 2013; Yeager & Dweck, 2012).

This interpretive role of GM is especially salient in GenAI-assisted writing contexts. GenAI can provide rapid suggestions, revisions, and explanations that resemble mastery-related experiences (Bouzar et al., 2024); however, whether learners construe these experiences as indicators of personal learning gains or as external assistance depends on their underlying beliefs about ability. Learners with a stronger growth mindset are more likely to view GenAI feedback as informational and improvement-oriented rather than evaluative or threatening, which may facilitate greater gains in writing self-efficacy (Dweck, 2006; Yeager & Dweck, 2012). Accordingly, GM is conceptualized as a boundary condition that amplifies or attenuates the motivational impact of GenAI use on writing self-efficacy.

H5: GM moderates the relationship between GenAI use and SE, such that the association is stronger for learners with higher GM

3. Methodology

3.1 Participants

Participants were recruited through Credamo, a professional Chinese online survey platform widely used in academic research and recognized for providing high-quality, reliable samples. A purposive sampling strategy was employed to target university students who had used GenAI to support L2 writing and had subsequently completed the CET-4. To ensure eligibility, respondents were screened using the question: "Have you used GenAI tools to assist your L2 writing for at least three months and subsequently taken the CET-4?" Only those who responded affirmatively were permitted to complete the survey.

A total of 262 valid questionnaires were retained for analysis. The sample comprised 107 males (40.84%) and 155 females (59.16%), with a mean age of 21.48 years. Regarding GenAI usage, participants reported sustained engagement with GenAI-supported L2 writing: 140 students (53.44%) indicated daily use, while 122 students (46.56%) reported weekly use. Overall, the demographic and usage characteristics reasonably reflect key features of Chinese undergraduate learners preparing for CET-4, supporting the relevance of the sample for the present study.

3.2 Measurement of Items

The questionnaire used in this study consisted of two sections. The first section of the questionnaire collected demographic and background information, including participants' age, gender, grade, frequency of GenAI use for L2 writing, and their CET-4 writing score. The second section measured students' GenAI use, GM, SE, and MSU. Except for L2WP, which was obtained from self-reported standardized CET-4 writing subtest score, all constructs were assessed using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire was initially developed in English and then translated into Chinese for the target participants. A back-translation conducted by an English-language specialist ensured conceptual equivalence between the two versions. Three English teachers reviewed the Chinese questionnaire for clarity and comprehensibility, while two experts in applied linguistics and educational technology evaluated item relevance and content validity. Minor revisions were made based on their feedback.

GenAI use was measured using three items adapted from prior studies on AI-assisted writing practices (Escalante et al., 2023; Gayed et al., 2022). These items captured learners' frequency and functional use of generative AI tools across different stages of the English writing process. GM was assessed using four items adapted from Bai and Wang (2021) and Yao et al. (2024), which reflect learners' beliefs about the malleability of their English writing ability. Writing SE was measured using five items adapted from Shen et al. (2024) and Zhang and Zhang (2024), focusing on learners' perceived capability to generate ideas and successfully perform English writing tasks. MSU was assessed using six items adapted from Farahian (2017), which capture learners' strategic regulation of planning, monitoring, and evaluation during the writing process. All items are provided in Appendix A.

3.3 Procedure

Data were collected via the Credamo online survey platform. Before participation, respondents were informed of the study's purpose and provided electronic informed consent. They were assured that participation was voluntary, that they could withdraw at any time without penalty, and that all responses would be treated as confidential and anonymous. Participants completed the online questionnaire, which took approximately 5–8 minutes. A total of 278 questionnaires were initially collected. During data screening, 16 patterned or inattentive responses were excluded, leaving 262 valid cases for subsequent analysis.

3.4 Data Analysis

The hypothesized model was tested using SmartPLS 4. Following a two-stage approach (Hair, 2014), we first evaluated the reflective measurement model (indicator loadings, internal consistency reliability, AVE, and discriminant validity via the Fornell–Larcker and HTMT criteria). We then assessed the structural model (collinearity via VIF, path coefficients, R^2) and tested mediation and interaction effects using bootstrapping with 5,000 resamples. Indirect effects were evaluated using bias-corrected confidence intervals.

Compared to covariance-based SEM (CB-SEM), PLS-SEM is particularly well-suited for prediction-oriented and theory-building research, especially in emerging research contexts and when estimating models with complex relationships (Hair et al., 2019). PLS-SEM was appropriate because this study examines GenAI-supported L2 writing in an emerging context where the measurement of GenAI use is still developing. It was also suitable for robustly estimating the proposed complex model with serial mediation and simultaneous moderation effects.

4. Results

4.1 Measurement Model

All reflective constructs (GenAI use, GM, SE, and MSU) demonstrated satisfactory measurement properties. Outer loadings ranged from 0.743 to 0.872 (Figure 1), exceeding the recommended threshold of 0.70, indicating that the indicators were strongly associated with their respective latent constructs. Internal consistency reliability was supported with Cronbach's α values between 0.819 and 0.880, rho_A (ρA) between 0.824 and 0.885, and composite reliability (CR; ρc) between 0.892 and 0.909, suggesting adequate internal consistency across all constructs. Convergent validity was established, with AVE values ranging from 0.626 to 0.734, indicating that each construct explained more than 50% of the variance in its indicators (Table 1).

Discriminant validity was supported: (a) Fornell–Larcker results showed that the square root of each construct's AVE exceeded its correlations with other constructs (Table 2), (b) Examination of cross-loadings indicated that each indicator loaded highest on its associated construct (Table 3), and (c) all HTMT ratios were below 0.85, indicating satisfactory discriminant validity (Table 4). L2WP was operationalized as an observed CET-4 writing subtest score. It was therefore not included in the reflective measurement model assessment (i.e., no loadings, AVE, CR, Fornell–Larcker, or HTMT were computed for L2WP).

Table 1: Construct reliability and validity

Construct	Cronbach's α	rho_A (ρA)	Composite Reliability (ρc)	AVE
GM	0.839	0.843	0.892	0.674
GenAI	0.819	0.824	0.892	0.734
MSU	0.880	0.885	0.909	0.626
SE	0.861	0.862	0.900	0.642

Table 2: Fornell-Larcker criterion

Construct	GM	GenAI	MSU	SE
GM	0.821			
GenAI	0.48	0.857		
MSU	0.387	0.417	0.791	
SE	0.386	0.357	0.526	0.801

Table 3: Cross loadings

Item	GM	GenAI	MSU	SE
GM_1	**0.805**	0.379	0.299	0.303
GM_2	**0.822**	0.407	0.305	0.336
GM_3	**0.814**	0.447	0.347	0.285
GM_4	**0.842**	0.35	0.324	0.338
GenAI_1	0.347	**0.867**	0.379	0.302
GenAI_2	0.407	**0.831**	0.32	0.276
GenAI_4	0.476	**0.872**	0.37	0.336
MSU_2	0.219	0.195	**0.743**	0.295
MSU_3	0.291	0.328	**0.778**	0.356
MSU_4	0.301	0.331	**0.81**	0.487
MSU_6	0.352	0.352	**0.779**	0.423
MSU_7	0.301	0.35	**0.828**	0.469
MSU_8	0.36	0.4	**0.807**	0.436
SE_1	0.311	0.235	0.368	**0.817**
SE_2	0.321	0.311	0.408	**0.796**
SE_4	0.311	0.277	0.458	**0.81**
SE_5	0.299	0.304	0.371	**0.771**
SE_7	0.303	0.3	0.489	**0.811**

Table 4: Heterotrait-Monotrait ratio

Construct	GM	GenAI	MSU	SE
GM	—			
GenAI	0.58	—		
MSU	0.448	0.484	—	
SE	0.452	0.422	0.593	—

4.2 Structural model

Before hypothesis testing, collinearity among predictors was assessed using VIF. All VIF values were below 3.3, indicating no serious multicollinearity concerns.

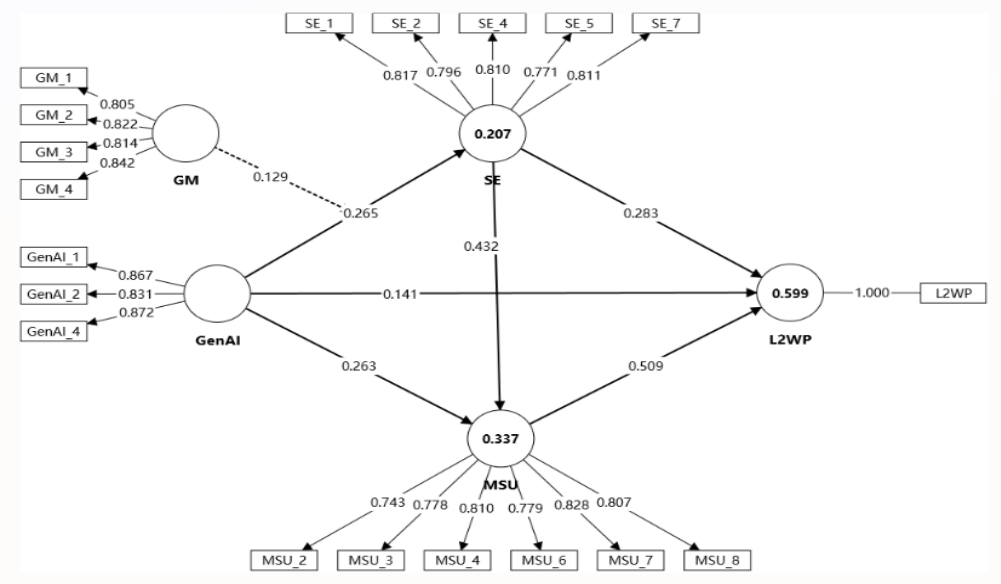

Figure 1: Structural Model

Note. During measurement model refinement, indicators with standardized loadings below 0.70 were removed (GenAI_3; SE_3 and SE_6; MSU_1 and MSU_5). The final model retained 5 SE items, 6 MSU items, 3 GenAI items, and 4 GM items.

Table 5: Hypothesis testing

Hypothesis	β	P values	95% CI		Decision
H1: GenAI -> L2WP	0.141	0.001	0.058	0.217	Accepted
H2: GenAI -> SE -> L2WP	0.075	0.002	0.033	0.129	Accepted
H3: GenAI -> MSU -> L2WP	0.134	< .001	0.064	0.204	Accepted
H4: GenAI -> SE -> MSU -> L2WP	0.058	0.001	0.027	0.095	Accepted
H5: GM x GenAI -> SE	0.129	0.027	0.006	0.237	Accepted

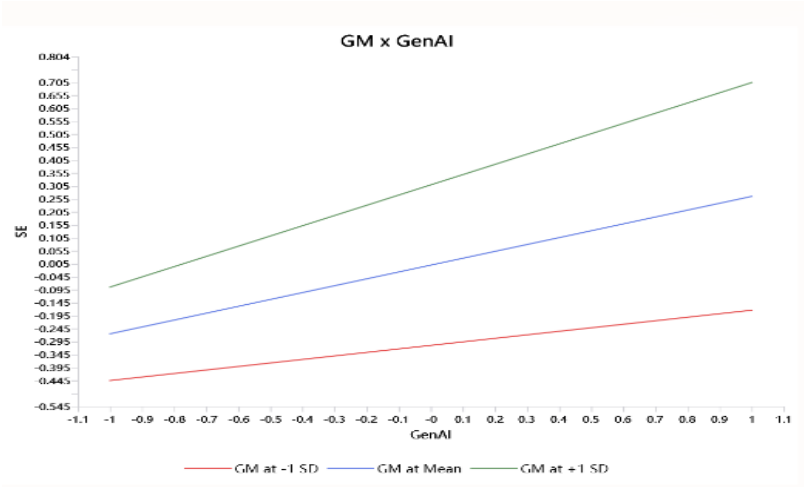

Figure 2: Simple slopes

As shown in Figure 1 and Table 5, GenAI use was positively associated with SE ($\beta = 0.265$, $p < .001$), MSU ($\beta = 0.263$, $p < .001$), and L2WP ($\beta = 0.141$, $p = .001$), supporting H1. This suggested that GenAI use is linked not only to learners' writing performance but also to motivational and strategic processes. GM also positively predicted SE ($\beta = 0.310$, $p < .001$), indicating that learners with stronger GM tend to report higher writing SE. In addition, SE positively predicted MSU ($\beta = 0.432$, $p < .001$) and L2WP ($\beta = 0.283$, $p < .001$), while MSU showed a strong positive effect on L2WP ($\beta = 0.509$, $p < .001$). Regarding moderation, the interaction term between GenAI use and GM significantly predicted SE ($\beta = 0.129$, $p = .027$), supporting H5.

This suggests that a GM may strengthen learners' ability to benefit motivationally from GenAI-supported writing. Simple slope (Figure 2) analyses showed that GenAI use was significantly and positively associated with SE at high (+1 SD; $\beta = 0.394$, $p < .001$) and mean levels of GM ($\beta = 0.265$, $p < .001$), but not at low (−1 SD) levels ($\beta = 0.136$, $p = .111$). This pattern indicated that the positive association between GenAI use and SE became stronger at higher levels of GM. The model explained 20.7% of the variance in SE ($R^2 = 0.207$), 33.7% in MSU ($R^2 = 0.337$), and 59.9% in L2WP ($R^2 = 0.599$), indicating moderate explanatory power for SE and MSU and substantial explanatory power for L2WP.

Bootstrapped mediation analyses (5,000 resamples) (Table 5) indicated that GenAI use was indirectly related to L2WP via SE ($\beta = 0.075$, 95% CI [0.033, 0.129]), supporting H2, and via MSU ($\beta = 0.134$, 95% CI [0.064, 0.204]), supporting H3. A significant sequential indirect effect through SE → MSU was also observed ($\beta = 0.058$, 95% CI [0.027, 0.095]), supporting H4. All 95% bias-corrected confidence intervals excluded zero, confirming the significance of these indirect effects.

5. Discussion

5.1 The Impact of GenAI Use on L2WP

The findings showed that GenAI use was positively associated with L2WP, supporting H1. This result aligns with prior research, which shows that AI-based writing tools can support L2 learners by providing timely feedback, linguistic scaffolding, and model texts (Gayed et al., 2022; Song & Song, 2023). Extending this work, the present study demonstrated that GenAI use was associated with writing performance not only through a direct pathway but also indirectly via theoretically grounded motivational and strategic mechanisms.

The study was conducted in an exam-oriented context, where learners are strongly motivated to improve writing proficiency. Under such conditions, GenAI use appeared to function less as a shortcut tool and more as a learning partner that supports sustained engagement with writing tasks. This suggested that the effectiveness of GenAI use might depend on learners' goals and orientations, echoing prior research emphasizing purposeful engagement in technology-supported learning (Han et al., 2025). Unlike studies portraying AI tools primarily as efficiency-enhancing or shortcut-oriented resources, the

present findings suggested that GenAI use supports writing performance through sustained engagement. This difference may be attributed to the exam-oriented context of the study, where performance goals encourage learners to use GenAI strategically rather than superficially.

5.2 The Mediating Role of SE between GenAI Use and L2WP

Our findings indicated that writing SE significantly mediated the relationship between GenAI use and L2WP, thereby supporting H2. This result underscored SE as a key motivational mechanism through which GenAI use translates into performance gains, suggesting that GenAI is related to writing outcomes not only through direct assistance but also by strengthening learners' confidence in managing writing tasks. This interpretation is consistent with prior research highlighting SE's central role in self-regulated learning, particularly in shaping learners' persistence, effort, and strategic engagement during writing (Pajares, 2003; Zimmerman, 2000).

L2 writing is cognitively demanding and often accompanied by apprehension and avoidance, particularly in high-stakes exam contexts (Johnson, 2017; Zhang & Zhang, 2022). From a social cognitive perspective, self-efficacy reflects learners' perceived capability to manage writing demands and regulate their performance (Bandura, 1997). In GenAI-supported writing contexts, interactive and non-judgmental feedback provided learners with opportunities to diagnose problems, test revisions, and observe incremental improvement. Such iterative engagement resembles mastery-related experiences—the most influential source of self-efficacy—through which learners may gradually develop a stronger sense of competence in handling writing tasks (Bandura, 1997; Usher & Pajares, 2008). This strengthened writing self-efficacy, in turn, was likely to be associated with improved writing performance (Golparvar & Khafi, 2021; Pajares, 2003) in exam-oriented settings.

5.3 The Mediating Role of MSU between GenAI Use and L2WP

Supporting H3, MSU significantly mediated the relationship between GenAI use and L2WP, highlighting a strategy-driven pathway through which GenAI use contributes to writing outcomes. This finding suggested that GenAI use was associated with writing performance not merely by providing linguistic assistance, but by fostering learners' active regulation of the writing process.

Compared with traditional forms of writing support, GenAI offered immediate and adaptive feedback that may facilitate continuous metacognitive regulation during writing. Learners could use GenAI to generate ideas and plan text structure, monitor coherence and language use during drafting, and evaluate revisions in real time. These affordances created frequent opportunities for strategic engagement that were previously constrained by delayed or limited feedback. Although prior studies had suggested that AI-based feedback could support metacognitive engagement in writing (Guo et al., 2025; Luo & Yusuf, 2025), much of this evidence has been descriptive in nature. Extending this line of research, the present study provided quantitative mediation evidence

showing that MSU functions as a key psychological mechanism linking GenAI use to improved L2WP.

5.4 The Serial Mediating Role of SE and MSU between GenAI Use and L2WP

Consistent with H4, SE and MSU functioned as sequential mediators in the relationship between GenAI use and L2 writing performance, revealing a motivational–strategic pathway underlying writing gains. This pattern supports an interpretation that GenAI-supported writing is associated not only with enhanced confidence or strategic engagement in isolation, but also with the activation of a confidence-to-regulation sequence (Pintrich, 2004; Zimmerman, 2000).

This finding aligns with the core assumptions of SRL, which posited that motivational beliefs, such as self-efficacy, preceded and supported the enactment of regulatory strategies during learning (Pintrich, 2004; Zimmerman, 2000). Prior research in both general and writing-specific contexts had demonstrated that learners with stronger self-efficacy were more likely to engage in planning, monitoring, and evaluation strategies, thereby enhancing their performance (Pajares, 2003). However, empirical evidence for this sequential mechanism remained limited in GenAI-assisted writing contexts. By demonstrating a statistically supported serial mediation pathway, the present study extended SRL research by empirically validating the motivational–strategic sequence in GenAI-supported L2 writing.

5.5 The Moderating Role of GM between GenAI Use and SE

The present study found that GM significantly moderated the relationship between GenAI use and L2 writing SE, such that the positive association between GenAI use and SE was stronger among learners with higher GM levels. This finding supported H5 and identified GM as a crucial boundary condition influencing the motivational benefits of GenAI-supported writing. This pattern accords with growth mindset theory, which posits that beliefs about the malleability of ability influence how learners interpret feedback and learning experiences (Dweck, 2006; Yeager & Dweck, 2012).

Empirical research further indicated that learners with a stronger GM were more likely to construe corrective feedback as informative and effort-related, whereas those with weaker GM tended to interpret similar feedback as diagnostic of fixed ability (Zhang et al., 2024). In GenAI-assisted writing contexts, where learners were repeatedly exposed to AI-generated suggestions and revisions, individuals with stronger GM might therefore be more inclined to interpret AI-supported improvements as evidence of personal learning and growth, thereby strengthening self-efficacy. This finding suggested that the motivational benefits of GenAI were not uniform and depended on learners' belief systems, highlighting the need for future research to examine additional individual differences.

6. Conclusion

Guided by the research objectives, this study examined the motivational and strategic mechanisms underlying the link between GenAI use and L2WP in an exam-oriented EFL context. The findings indicated that GenAI use was positively associated with L2WP both directly and indirectly, supporting the view that GenAI functions as a learning affordance embedded in learners' self-regulated learning processes rather than merely as a technological aid. With respect to the proposed mediating mechanisms, SE and MSU were found to mediate the relationship between GenAI use and L2WP independently and sequentially, revealing a motivational–strategic pathway through which confidence gains associated with GenAI use are translated into improved performance via enhanced strategic regulation. In addition, growth mindset moderated the relationship between GenAI use and SE, indicating that learners' implicit beliefs about ability development condition the motivational benefits derived from GenAI-supported writing.

This study makes two key contributions. Theoretically, it integrates SCT, SRL, and GM to extend SCT-based explanations of GenAI-supported L2 writing, identifying a motivational–strategic pathway linking GenAI use to L2WP through SE and MSU, with GM as a boundary condition. Practically, the findings suggest that GenAI is most beneficial when used to build learners' SE and strategic regulation; thus, teachers can scaffold MSU and frame AI-assisted revision as effort-based improvement in exam-oriented settings. Limitations include reliance on self-reports, cross-sectional design, and uncontrolled individual differences. Future research should adopt longitudinal and experimental approaches and examine AI literacy and prompting skills as moderating factors.

7. Conflict of Interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix

Appendix A: Final Questionnaire Items Used in the Study

Generative AI use

1. During the process of writing in English, I frequently use GenAI tools at various stages.
2. I often use generative artificial intelligence tools to collect and organize materials or reference information needed for writing.
3. I utilize generative artificial intelligence to refine my writing or enhance its language quality.

Growth Mindset

1. Anyone can substantially improve their English writing ability through effort and practice, regardless of whether artificial intelligence tools are used.
2. I believe I can continuously improve my English writing ability through effort.
3. If I persist in practicing and learning, my English writing ability can develop significantly, even with the aid of artificial intelligence.
4. I would like to choose some complex writing topics.

Self-efficacy

1. I can come up with and write down many ideas for my English compositions.
2. I can think of appropriate words to express my ideas.
3. I can write linguistically accurate sentences (including grammar, spelling, and punctuation).
4. I can arrange and organize content in my writing reasonably.
5. I can see a day when I can write in English fluently and accurately.

Metacognitive Strategy Use

1. Before writing, I think carefully about what I want to express.
2. Before writing, I consider the overall structure of the text.
3. While writing, I check whether my sentences are clear and concise.
4. While writing, I check whether I am following my original plan.
5. After finishing writing, I check whether my text meets the task requirements.
6. After finishing writing, I revise my text to improve its quality.