Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Fostering multidimensional learning engagement through generative AI in Chinese L2 writing: A quasi-experimental investigation grounded in self-determination theory

XINYING LYU

xylyu@cup.edu.cn

China University of Petroleum-Beijing

Article

Keywords: generative artificial intelligence, ChatGPT, Chinese as a second language, writing instruction, learning engagement, self-determination theory

Posted Date: July 27th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9594766/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

The expanding availability of generative artificial intelligence (GenAI) tools, most notably ChatGPT, has created new opportunities for second language (L2) writing pedagogy. However, empirical evidence on how these tools influence different facets of learner engagement remains limited, particularly within Chinese as a second language (CSL) settings. Drawing on self-determination theory (SDT; Ryan & Deci, 2000), this quasi-experimental study involved 82 CSL learners at HSK Level 4 proficiency who participated in either a treatment condition (n = 41) incorporating teacher-facilitated ChatGPT writing workshops or a comparison condition (n = 41) following conventional instruction. Engagement was operationalized along three dimensions: behavioral, cognitive, and emotional engagement. Mixed ANOVAs revealed significant Group × Time interactions for behavioral engagement ($F = 4.35$, $p = .040$, $\eta p^2 = .052$), cognitive engagement ($F = 4.33$, $p = .041$, $\eta p^2 = .051$), and emotional engagement ($F = 11.63$, $p = .001$, $\eta p^2 = .127$). Simple-effect analyses indicated that behavioral engagement increased significantly in the treatment group, whereas cognitive and emotional engagement were maintained in the treatment group but declined, or approached decline, in the comparison group. Interpreted through the SDT lens of autonomy, competence, and relatedness, the findings suggest that teacher-mediated GenAI integration may support behavioral activation and help stabilize cognitive and emotional engagement during CSL writing, although direct within-treatment gains were not observed across all dimensions. Practical implications for constructing AI-augmented L2 writing curricula that combine technological scaffolding with learner agency are discussed.

1. Introduction

The launch of ChatGPT by OpenAI in November 2022 catalyzed a wave of scholarly inquiry into the pedagogical affordances of generative AI across diverse educational settings. Functioning as a large-language-model-based chatbot that produces contextually appropriate text, parses complex prompts, and sustains multi-turn conversations, ChatGPT has been characterized as both a virtual practice partner for language learners and a pedagogical scaffold for writing instructors (Kim et al., 2025). Research in second language writing has established that ChatGPT can detect morphosyntactic inaccuracies, suggest discourse connectors, and propose target-like idiomatic phrasing (Ghafouri, 2024). A systematic mapping of 73 empirical reports identified ChatGPT as the most frequently employed generative AI platform in L2 writing research, while simultaneously highlighting a notable gap: investigations remain heavily skewed toward English, with character-based target languages such as Chinese receiving far less scholarly attention (Yang et al., 2025).

Composing in an L2, however, extends well beyond surface-level accuracy. A comprehensive account of writing development must encompass persistent task-directed behavior, favorable affective dispositions toward the composing activity, and deliberate deployment of higher-order cognitive strategies (Ellis, 2010). SDT provides a principled theoretical lens for examining these facets: it predicts that engagement deepens when a learning activity satisfies three fundamental psychological needs—autonomy (perceived volition and self-direction), competence (a sense of effectiveness and growing mastery), and relatedness

(felt connection and belonging) (Ryan & Deci, 2000). Evidence indicates that when these three needs are adequately nourished, learners invest more sustained effort and display elevated intrinsic motivation (Bai & Gu, 2024; Guo et al., 2025; Oluwaseyi et al., 2024). A recent synthesis examining SDT in relation to AI chatbots and language pedagogy concluded that ChatGPT has the capacity to support each of these needs, though the teacher's scaffolding role remains vital for sustaining autonomous engagement (Li et al., 2025).

Within writing tasks specifically, GenAI tools may bolster CSL learners' competence perceptions through corrective feedback on grammar, structural organization, and lexical range, while simultaneously promoting autonomy by enabling self-directed revision cycles (Tang, 2024; Teng, 2025). Wang (2024) demonstrated that self-regulated deployment of machine translation and GenAI tools in academic writing involves intricate cognitive and sociocultural dynamics, with learner agency serving as a critical mediator between tool use and writing outcomes. Ghafouri (2024) showed that a rapport-building protocol mediated by ChatGPT significantly enhanced L2 grit, positioning the tool as a catalyst for perseverance. Muñoz Muñoz et al. (2025) compared ChatGPT-generated and human-provided direct corrective feedback and found that the AI condition yielded broadly superior writing gains.

Nevertheless, apprehensions persist. Unchecked reliance on AI-generated corrections may erode learners' independent problem-solving capacity (Feng, 2023). Empirical evidence suggests that once automated correction frequency surpasses certain thresholds, grammatical internalization may plateau at superficial correction stages, fostering tool dependency (Shi et al., 2025). Recent evidence also indicates that AI-based writing support can produce mixed motivational and self-concept outcomes; for example, Shi et al. (2025) found that ChatGPT improved writing performance but also affected learners' ideal L2 writing self in complex ways. Wang and Zou (2026) further showed that learners' feedback engagement with ChatGPT can be cognitively robust but uneven across motivational and emotional dimensions.

Against this backdrop, three salient gaps motivate the current investigation. First, CSL writing poses distinctive challenges—including character-based orthography, complex collocational patterns, and culturally inflected discourse conventions—that have received insufficient empirical attention in the GenAI literature (Chen et al., 2026; Shan et al., 2025). Second, although learning engagement is widely theorized as multidimensional, few studies have concurrently examined behavioral, cognitive, and emotional dimensions under AI-mediated conditions using controlled experimental designs. Third, SDT, while increasingly cited, has rarely been operationalized systematically to illuminate how GenAI tools differentially affect each engagement facet. Accordingly, this study addresses the following research questions:

RQ1. Does a teacher-facilitated ChatGPT-integrated CSL writing course produce differential changes in behavioral, cognitive, and emotional engagement compared with conventional instruction?

RQ2. How do engagement levels change within each instructional condition from pre-test to post-test?

2. Theoretical background and related work

2.1 GenAI-mediated Chinese L2 writing instruction

Within the broader AI-in-education landscape, teaching Chinese composition to L2 learners constitutes a distinctive challenge. The Chinese writing system demands facility with logographic characters, tonal sensitivity, and discourse norms deeply rooted in cultural tradition—factors that create specialized requirements for AI-driven pedagogical support (Chen, 2024). Initial AI-based evaluation systems for Chinese writing were largely restricted to detecting surface grammatical errors and delivering template-based feedback. The emergence of large language models, exemplified by ChatGPT, has markedly expanded the support repertoire from basic error flagging to nuanced, contextualized guidance covering vocabulary selection, organizational coherence, and cultural register (Ren et al., 2024; Wu, 2024). In a controlled comparison, Zhang et al. (2025) found that whereas AI-only feedback improved grammatical range among 60 Chinese EFL learners, a blended condition combining AI and human input produced notably larger gains in essay organization and analytical depth.

Research has further shown that GenAI can facilitate pre-writing planning, paragraph development, and cyclical self-editing (Wiboolyasarin et al., 2024; Yan & Zhang, 2024). In the reflective stages of writing, instant AI feedback helps learners locate weaknesses and polish their prose, progressively building self-evaluation skills (Cai, 2024). Teng (2025) investigated metacognitive awareness among EFL writers using ChatGPT and observed that those with sharper metacognitive skills leveraged AI suggestions more purposefully. Shan et al. (2025), contrasting GPT-4–facilitated and native-speaker interaction for CSL writing tasks, concluded that AI can supplement human interlocutors but cannot fully substitute for them, especially regarding higher-order rhetorical and culturally situated competencies. Despite these advances, scholarly discourse continues to grapple with the risks of excessive dependence on machine-generated text and the attendant academic integrity concerns (Ou et al., 2024).

2.2 Learning engagement in AI-augmented language education

Learning engagement—broadly defined as the sustained effort, temporal investment, and psychological commitment learners direct toward academic goals (Kuh, 2001)—is most commonly parsed into three interlocking facets: behavioral engagement, referring to observable involvement such as class attendance and assignment completion; cognitive engagement, which captures the depth of mental strategies and self-monitoring that learners employ; and emotional engagement, encompassing subjective feelings of interest, curiosity, and satisfaction (Sadoughi et al., 2023). Together, these facets constitute the motivational foundation that underpins productive learning and drives outcome improvement (Xu et al., 2025). The infusion of AI tools is reconfiguring how engagement manifests, transitioning instruction from the familiar teacher–student pair to an expanded teacher–student–AI configuration in which instant evaluative input and individualized guidance make the composing journey more transparent at every stage.

Recent investigations have produced nuanced findings regarding GenAI's impact on engagement dimensions. A meta-analysis of AI-assisted language learning and learner agency found that engagement exhibited the largest pooled effect size among the examined agency-related outcomes, indicating that AI-supported learning may be particularly relevant to learner participation (Zai & Zhou, 2026). Bhuiyan et al. (2026) found that ChatGPT usage patterns diverged substantially between developed and developing-country contexts, with engagement mediated by differences in technological infrastructure and digital literacy. Lu et al. (2026) demonstrated that a GenAI-supported feedback practice substantially improved student feedback literacy in L2 writing through a triadic model encompassing preparatory scaffolding, diversified feedback sources, and reflective reinforcement. Yan and Zhang (2024) examined writers' behavioral, cognitive, and affective engagement with ChatGPT-provided automated corrective feedback, reporting strong cognitive engagement but superficial affective responses—a finding the present study further probes. Conversely, Georgiou (2025) cautioned that AI assistance may precipitate cognitive offloading, with the ChatGPT group displaying significantly lower cognitive engagement than the control group, thereby foregrounding the critical role of instructional design in mediating AI's effects.

2.3 Self-determination theory as an analytical framework

SDT (Ryan & Deci, 2000) furnishes a well-validated framework for analyzing how technology-mediated learning environments shape engagement. Central to the theory is the proposition that deep, self-sustained engagement emerges when a learning context nourishes three core psychological requirements: the need for autonomy, satisfied when learners perceive genuine choice and self-direction; the need for competence, addressed through optimally calibrated challenges paired with actionable feedback; and the need for relatedness, fulfilled through bonds of trust and mutual regard within a learning community. A recently validated Human–Computer Collaborative Classroom L2 Learning Engagement Scale, grounded in SDT and socio-constructivist perspectives, confirmed the five-dimensional structure of engagement in AI-mediated language classrooms, providing psychometric evidence that autonomy, competence, and relatedness remain operative in human–AI collaborative settings (Jiang & Liu, 2026). Li et al. (2025) systematically reviewed research on AI chatbots and language learning from an SDT perspective and concluded that ChatGPT can support all three needs, though teacher facilitation remains critical for autonomy scaffolding. Annamalai and Nasor (2025), using an SDT lens to examine learners' ChatGPT experiences, similarly indicated that ChatGPT may support competence and autonomy perceptions, while relatedness remains contingent on human interaction and instructional context.

Within L2 writing specifically, Bekdaş (2026) demonstrated that personalized, always-available ChatGPT support can bolster all three needs and sustain engagement even under difficulty. Zare et al. (2025) found that ChatGPT interaction positively and durably influenced L2 learners' task motivation for argumentative writing, although a decline at the delayed post-intervention stage underscored the importance of balancing AI support with independent capability development. Collectively, these findings indicate that while GenAI can support SDT-related needs, the degree and durability of that support vary

across dimensions and are contingent on instructional design—a hypothesis the present study puts to empirical test. Figure 1 presents the theoretical framework, depicting how teacher-mediated ChatGPT support and the CSL writing-task ecology connect to the three basic psychological needs and, in turn, to the three engagement dimensions.

3. Method

3.1 Participants and context

Eighty-two CSL learners enrolled in an Advanced Writing course at a Chinese university constituted the analytic sample. All participants had attained HSK Level 4 certification, indicating intermediate proficiency sufficient for academic writing tasks. Participants were allocated to either a treatment group (n = 41) or a comparison group (n = 41) on the basis of their pre-existing class sections. During writing activities, treatment-group learners utilized ChatGPT to support ideation, drafting, and self-revision through interactive AI dialogue, whereas comparison-group learners completed identical tasks under conventional instruction without AI support. Within the treatment condition, the instructor orchestrated group discussions incorporating ChatGPT-generated feedback to help learners diagnose writing weaknesses, stimulate composing motivation, and deepen participation. Pre-test comparisons did not reach statistical significance for behavioral engagement ($F = 0.32$, $p = .575$), cognitive engagement ($F = 0.98$, $p = .325$), or emotional engagement ($F = 3.31$, $p = .072$), although emotional engagement was descriptively higher in the treatment group at baseline.

3.2 Ethics and Consent

The study received ethical approval or exemption from the relevant institutional ethics committee at the author's institution. The committee name, approval or exemption details, and institutional identifiers have been blinded for peer review and are provided in editable form in the cover letter. All research procedures were conducted in accordance with the ethical guidelines and regulations of the author's institution and relevant national regulations governing educational research involving human participants. Informed consent was obtained from all participants before data collection. Participation was voluntary, and participants were informed that they could withdraw from the study at any time without penalty. All responses were anonymised and analysed only in aggregate form.

3.3 Instruments

Data were gathered via a Chinese L2 writing engagement questionnaire adapted from established multidimensional engagement measures in language-learning contexts (Khajavy, 2021; Wang & Che, 2026). The instrument used a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree) and contained 13 items spanning three dimensions: behavioral engagement (Items 1–4; sample item: "I concentrate on Chinese writing activities during class"), cognitive engagement (Items 5–9; sample item: "When I encounter difficulties in Chinese writing, I try different strategies to solve them"), and emotional engagement (Items 10–13; sample item: "I find Chinese writing activities interesting"). No items were

reverse-coded. In the present sample, pre-test internal consistency was acceptable to good for behavioral engagement (α = .88), cognitive engagement (α = .79), emotional engagement (α = .87), and the overall scale (α = .88). Post-test reliability estimates were similarly acceptable for behavioral engagement (α = .83), cognitive engagement (α = .75), emotional engagement (α = .77), and the overall scale (α = .91). Corrected item–total correlations exceeded .46 at pre-test and .52 at post-test. A pre-test item-level diagnostic supported factorability (KMO = .825; Bartlett's $\chi^2[78] = 635.52$, $p < .001$), and a three-component solution accounted for 69.61% of the variance.

3.4 Instructional procedures

Prior to the instructional intervention, every participant completed the baseline engagement survey. The pedagogical design wove together reading comprehension training and two successive two-week collaborative writing cycles aimed at building both cooperative and solo composing abilities. Within each cycle, learners were organized into five-person teams responsible for co-authoring a five-paragraph essay—one introductory section, three developmental paragraphs, and a concluding section—with each team member taking charge of a single paragraph. Topics were drawn from course reading materials, and learners were expected to incorporate the rhetorical techniques and linguistic strategies taught in class.

In the first week, learners sketched flowcharts, assembled outlines, and composed preliminary drafts. Within-team dialogue ensured alignment in argumentative logic, stylistic register, and thematic coherence. A key design decision was to keep all first-week activities entirely pen-and-paper, thereby discouraging premature AI dependence and directing learners' focus toward Chinese syntactic and pragmatic competence. During the second week, learners brought completed paragraphs and turned to ChatGPT for evaluative input. A prompt checklist supplied by the instructor channeled feedback requests toward grammatical precision, logical consistency, and lexical appropriateness. All ChatGPT dialogue logs were submitted via the university's online learning platform, and AI-informed revisions were marked on handwritten drafts. By the end of Week 2, each team submitted a polished essay alongside annotated revision records.

3.5 Analytical approach

Quantitative data were processed using R (version 4.3.1). Dimension scores were computed as the mean of the corresponding item scores at pre-test and post-test. Distributional normality was evaluated via the Shapiro–Wilk test, and internal consistency was examined using Cronbach's α coefficients. Mixed two-way ANOVAs tested the Group × Time interaction for each engagement dimension, with group as the between-subjects factor and time as the within-subjects factor. Where significant interactions emerged, simple-effect analyses examined between-group differences at each time point and within-group changes from pre-test to post-test. Effect sizes are reported as partial eta squared (ηp^2).

4. Results

4.1 Descriptive overview

Descriptive statistics indicated divergent trajectories across instructional conditions. The treatment group showed small positive changes in behavioral, cognitive, and emotional engagement, whereas the comparison group showed declines across the same interval. Behavioral engagement increased from 3.38 to 3.71 in the treatment group but changed only slightly from 3.23 to 3.16 in the comparison group. Cognitive engagement remained comparatively stable in the treatment group, increasing from 3.61 to 3.69, whereas the comparison group declined from 3.85 to 3.44. Emotional engagement also remained stable in the treatment group, increasing from 4.43 to 4.51, whereas the comparison group declined from 4.04 to 3.57. Table 1 presents the descriptive statistics, normality estimates, and reliability coefficients; Fig. 2 visualizes the group-by-time trajectories across the three dimensions.

Table 1
Descriptive statistics for learning engagement by dimension, group, and time.

Dimension	Group	n	Pre M (SD)	Post M (SD)	W pre/post	α pre/post
Behavioral	Treatment	41	3.38 (1.24)	3.71 (1.16)	.98/.97	.88/.83
Behavioral	Comparison	41	3.23 (1.11)	3.16 (1.10)	.95/.95	.84/.85
Cognitive	Treatment	41	3.61 (1.12)	3.69 (1.12)	.96/.98	.79/.75
Cognitive	Comparison	41	3.85 (1.06)	3.44 (1.14)	.96/.98	.78/.86
Emotional	Treatment	41	4.43 (0.89)	4.51 (0.85)	.97/.95	.87/.77
Emotional	Comparison	41	4.04 (1.05)	3.57 (0.97)	.97/.96	.91/.87

Note. M = mean; SD = standard deviation; W = Shapiro–Wilk statistic; α = Cronbach's alpha. Values in the W and α columns are reported as pre-test/post-test estimates.

4.2 Inferential analyses

Mixed ANOVAs were performed to evaluate the Group × Time interaction for each engagement dimension. Table 2 summarizes the omnibus results. Because all three Group × Time interactions reached statistical significance, simple-effect analyses were conducted for behavioral, cognitive, and emotional engagement.

Table 2
Mixed ANOVA results for learning engagement.

Dimension	Effect	F	p	ηp²
Behavioral	Group	2.18	.144	.027
Behavioral	Time	1.76	.188	.022
Behavioral	Group x Time	4.35	.040	.052
Cognitive	Group	0.00	.973	< .001
Cognitive	Time	2.02	.159	.025
Cognitive	Group x Time	4.33	.041	.051
Emotional	Group	11.97	< .001	.130
Emotional	Time	5.88	.018	.068
Emotional	Group x Time	11.63	.001	.127

Behavioral engagement. A significant Group × Time interaction emerged ($F[1, 80] = 4.35$, $p = .040$, $\eta p^2 = .052$), whereas the main effect of group ($F[1, 80] = 2.18$, $p = .144$, $\eta p^2 = .027$) and the main effect of time ($F[1, 80] = 1.76$, $p = .188$, $\eta p^2 = .022$) were not statistically significant. Simple-effect analyses (Table 3) showed no pre-test group difference. At post-test, the treatment group reported significantly higher behavioral engagement than the comparison group. Within-group analyses indicated that behavioral engagement increased significantly in the treatment group, whereas the comparison group did not change significantly.

Table 3
Simple-effect analyses for behavioral engagement.

Source	df1	df2	F	p	ηp²
Pre-group diff.	1	80	0.32	.575	.004
Post-group diff.	1	80	4.86	.030	.057
Treat. change	1	40	4.86	.033	.108
Comp. change	1	40	0.36	.553	.009

Cognitive engagement. The mixed ANOVA indicated a significant Group × Time interaction ($F[1, 80] = 4.33$, $p = .041$, $\eta p^2 = .051$), while neither the main effect of group ($F[1, 80] < 0.01$, $p = .973$, $\eta p^2 < .001$) nor the main effect of time ($F[1, 80] = 2.02$, $p = .159$, $\eta p^2 = .025$) was significant. Simple-effect analyses (Table 4) indicated no significant between-group difference at either time point. The treatment group's cognitive engagement remained statistically stable, whereas the comparison group's decline approached, but did not meet, the conventional .05 threshold ($p = .0505$).

Table 4
Simple-effect analyses for cognitive engagement.

Source	df1	df2	F	p	ηp²
Pre-group diff.	1	80	0.98	.325	.012
Post-group diff.	1	80	1.04	.311	.013
Treat. change	1	40	0.44	.511	.011
Comp. change	1	40	4.07	.050	.092

Emotional engagement. The analysis revealed a significant main effect of group ($F[1, 80] = 11.97$, $p < .001$, $\eta p^2 = .130$), a significant main effect of time ($F[1, 80] = 5.88$, $p = .018$, $\eta p^2 = .069$), and a significant Group × Time interaction ($F[1, 80] = 11.63$, $p = .001$, $\eta p^2 = .127$). Simple-effect analyses (Table 5) showed that the pre-test group difference did not reach statistical significance, whereas the treatment group reported significantly higher emotional engagement at post-test. Within-group analyses indicated that emotional engagement remained stable in the treatment group but declined significantly in the comparison group.

Table 5
Simple-effect analyses for emotional engagement.

Source	df1	df2	F	p	ηp²
Pre-group diff.	1	80	3.31	.072	.040
Post-group diff.	1	80	21.62	< .001	.213
Treat. change	1	40	0.59	.446	.015
Comp. change	1	40	14.45	< .001	.265

Note. Group diff. = between-group difference. Change = within-group post-test versus pre-test comparison.

5. Discussion

The findings provide empirical evidence that a teacher-mediated GenAI writing course was associated with divergent trajectories in behavioral, cognitive, and emotional engagement over time. The pattern was not uniform across dimensions. Behavioral engagement showed a modest but statistically significant increase within the treatment group. Cognitive engagement showed a small, non-significant increase in the treatment group and an approaching-significant decline in the comparison group. Emotional engagement was maintained in the treatment group but declined significantly in the comparison group. These results are examined below through the prism of SDT and situated within the evolving research landscape.

This pattern is theoretically meaningful because engagement in sustained writing instruction is not expected to remain constant by default. Repeated drafting, revision, and feedback cycles often impose cumulative cognitive and motivational demands, particularly for intermediate CSL learners who must coordinate character accuracy, lexical choice, sentence-level grammar, discourse coherence, and culturally appropriate expression. Against this background, the behavioral gain and the relative preservation of cognitive and emotional engagement in the treatment group can be interpreted as pedagogically relevant outcomes. Rather than demonstrating that ChatGPT automatically increases all facets of engagement, the results indicate that teacher-facilitated AI support may help stabilize learners' participation, strategic processing, and affective orientation when the writing workload becomes more demanding. This interpretation also provides a cautious account of GenAI in L2 writing: the tool's value lies not in replacing teacher feedback or learner effort, but in extending the feedback ecology in ways that make revision more immediate, visible, and manageable. Such a finding is consistent with SDT because competence support, structured autonomy, and teacher-mediated interaction may help learners continue investing effort even when tasks become challenging.

5.1 Behavioral engagement and autonomy

The significant Group × Time interaction for behavioral engagement indicates that treatment-group learners became more behaviorally engaged over time, whereas comparison-group learners remained comparatively stable. This result should still be interpreted with caution because the effect size was modest. The finding accords with an expanding evidence base showing that AI-mediated pedagogical support may activate task involvement when instruction is carefully mediated by the teacher (Bellas et al., 2024; Ragolane et al., 2024). ChatGPT's capacity to deliver instant corrective feedback and revision prompts may have encouraged learners to participate more actively in drafting, feedback-seeking, and revision activities. Xing and Teng (2026) similarly found that teachers' interpersonal behaviors significantly predicted students' behavioral, cognitive, and emotional engagement with GenAI, underscoring the importance of instructor mediation in AI-assisted classrooms. Viewed through the SDT lens, this outcome aligns with the prediction that structured choice regarding how and when to seek feedback can support autonomy and increase observable task participation.

5.2 Emotional engagement and relatedness

The emotional engagement results invite careful interpretation through the SDT lens. The significant interaction was driven primarily by a decline in the comparison group and relative stability in the treatment group, rather than by a significant emotional gain within the treatment group. Emotional engagement is closely linked to relatedness—the experience of meaningful social connection and belonging within a learning community. Because ChatGPT's affordances are predominantly oriented toward competence support, such as error correction and structural suggestions, its emotional value may depend on teacher mediation, peer collaboration, and classroom climate. The present findings therefore suggest an affective maintenance effect rather than direct affective enhancement. This interpretation converges with Wang and Zou's (2026) observation that feedback engagement with

ChatGPT can be cognitively robust while affective depth remains contingent on pedagogical design. Future iterations should explore collaborative AI-facilitated peer review and culturally responsive writing tasks to address learners' relatedness needs more effectively (Yao & Wang, 2024).

5.3 Cognitive engagement and competence

The significant Group × Time interaction for cognitive engagement likewise indicates a modest divergence in trajectories. Treatment-group learners maintained a relatively stable level of cognitive engagement, whereas the comparison group showed a decline that approached conventional significance. This pattern should not be overstated as a direct cognitive-enhancement effect, because the within-treatment change was small and non-significant. Nevertheless, the result is theoretically meaningful in sustained writing instruction: by delivering multi-layered feedback on grammatical accuracy, sentential structure, and logical organization, ChatGPT may help learners preserve cognitive investment during composing, including self-monitoring, hypothesis testing, and problem-solving. This interpretation is consistent with Teng's (2025) finding that metacognitively aware learners make more strategic use of AI feedback, as well as Ma and Xu's (2024) observation that technology-assisted tools can facilitate cognitive engagement and self-regulation in L2 writing. These findings should also be weighed alongside Georgiou's (2025) cautionary evidence regarding cognitive offloading. The structured pedagogical design employed in the present study, which required paper-based initial drafting prior to AI consultation, may have helped mitigate this risk by ensuring substantive cognitive processing before learners turned to AI support.

5.4 Implications for practice

Several actionable implications emerge. First, weaving GenAI into L2 writing curricula calls for a deliberate tapering strategy: scaffolding intensity should diminish progressively as learners build proficiency, thereby guarding against the dependency and self-concept risks discussed by Shi et al. (2025). Second, the muted emotional-engagement effect highlights a need for pedagogical innovations oriented toward SDT's relatedness dimension—for example, embedding collaborative AI-facilitated peer review or culturally responsive tasks that cultivate community feeling. Third, the instructor's guiding role proves indispensable: AI tools should complement, not displace, self-directed learning, a principle echoed in the critical teacher-mediation findings of Li et al. (2025). The theoretical model presented in Fig. 1 can function as a practical roadmap for educators constructing AI-enhanced CSL writing programs.

6. Conclusion

The present investigation examined how a GenAI-enhanced composing course shaped CSL learners' multidimensional engagement. Three principal findings emerged. First, the ChatGPT-integrated course was associated with a modest but significant increase in behavioral engagement, suggesting that teacher-mediated AI feedback can activate observable participation in writing tasks. Second, cognitive engagement showed a small maintenance pattern in the treatment group and a near-significant decline

in the comparison group, indicating that GenAI support may help preserve strategic investment during sustained writing practice rather than directly producing large cognitive gains. Third, emotional engagement remained stable in the treatment group but declined significantly in the comparison group, suggesting an affective buffering effect that depends on teacher mediation and classroom design. Framed within SDT, these results supply empirical evidence from a Chinese L2 writing context and indicate that teacher-mediated GenAI integration may function both as a modest behavioral activator and as a stabilizing support for cognitive and emotional engagement.

Several caveats apply. The participant pool (N = 82) was relatively small, which may limit statistical sensitivity and generalizability. Because participants were assigned by pre-existing class sections rather than through individual randomization, causal claims should be made cautiously. Although pre-test differences did not reach statistical significance, emotional engagement was descriptively higher in the treatment group, and future studies should consider ANCOVA, propensity-score methods, or larger randomized designs to strengthen baseline control. The study captured only short-term outcomes; future work should adopt longitudinal approaches to trace how AI-supported engagement evolves over extended periods and interacts with writing proficiency growth. The reliance on self-report engagement measures also introduces potential response bias, and subsequent research should triangulate questionnaire data with classroom observation, learning-platform traces, writing-process logs, and writing-quality outcomes. Lastly, given that the present inquiry was confined to CSL writing, broadening the lens to encompass additional language skills and diverse instructional contexts would reinforce the emerging evidence base for GenAI's role in language education.

Declarations

Funding

Funding information has been withheld from the anonymised manuscript for double-blind peer review and will be supplied in the submission system where author-identifying information is permitted.

Competing Interests

The author declares no competing interests.

Ethics and Consent

The study received ethical approval or exemption from full ethical review from the relevant institutional ethics committee at the author's institution, with the committee name, approval or exemption details, and institutional identifiers blinded for peer review. The full editable ethics statement has been provided in the cover letter. All research procedures were conducted in accordance with relevant institutional guidelines and national regulations governing educational research involving human participants. Informed consent was obtained from all participants before data collection.

Data Availability

The anonymised item-level raw dataset, processed analysis dataset, survey instrument and scoring documentation, data-collection and instructional protocol, variable codebook, transformation rules, statistical analysis script, and supplementary README supporting the findings of this study have been provided as supplementary files for editorial and peer-review purposes. The supplementary materials include S1, the deidentified raw dataset; S2, the processed analysis dataset; S3, the survey instrument and scoring documentation; S4, the data-collection and instructional protocol; S5, the variable codebook and transformation rules; S6, the statistical analysis script; and S7, the supplementary README. Direct personal identifiers have been removed before sharing.

Author Contribution

The sole author was responsible for conceptualization, methodology, formal analysis, investigation, data curation, writing – original draft, writing – review and editing, project administration, and funding acquisition.

References

1. Annamalai, N., & Nasor, M. (2025). Exploring ChatGPT in education: Unveiling learners' experiences through the lens of self-determination theory. Smart Learning Environments, 12, Article 59. https://doi.org/10.1186/s40561-025-00393-2
2. Bai, X., & Gu, X. (2024). Contribution of self-determination theory to K–12 students' online learning engagements: Research on the relationship among teacher support dimensions, students' basic psychological needs satisfaction, and online learning engagements. Educational Technology Research and Development. Advance online publication. https://doi.org/10.1007/s11423-024-10343-w
3. Bekdaş, M. (2026). ChatGPT: The artificial intelligence for fostering grit in second language writing classes. Humanities and Social Sciences Communications, 13, Article 203. https://doi.org/10.1057/s41599-026-06557-w
4. Bellas, F., Naya-Varela, M., Mallo, A., & Paz-Lopez, A. (2024). Education in the AI era: A long-term classroom technology based on intelligent robotics. Humanities and Social Sciences Communications, 11, Article 1425. https://doi.org/10.1057/s41599-024-03953-y
5. Bhuiyan, M. R. I., Uddin, S., Sultana, T., Al-Amin, & Islam, M. M. (2026). Investigating ChatGPT methods in higher education from a student engagement perspective. SAGE Open, 16(1), 1–16. https://doi.org/10.1177/21582440251413008
6. Cai, R. (2024). Attitudes and perceptions of teachers and Chinese students towards corrective feedback in L2 writing. Theory and Practice in Language Studies, 14(5). https://doi.org/10.17507/tpls.1405.05
7. Chen, X. (2024). ChatGPT yu eryu yuyong jiaoxue [ChatGPT and L2 pragmatic instruction]. Waiyu Jiaoxue Lilun Yu Shijian, (4), 1–10.

8. Chen, X., Zhou, X., & Goh, Y. S. (2026). How Chinese as a foreign language learners use generative AI for oral script-writing: A qualitative perspective on cognitive scaffolding in project-based learning. Acta Psychologica, 262, Article 106071. https://doi.org/10.1016/j.actpsy.2025.106071
9. Ellis, R. (2010). Epilogue: A framework for investigating oral and written corrective feedback. Studies in Second Language Acquisition, 32(2), 335–349. https://doi.org/10.1017/S0272263109990544
10. Feng, Y. (2023). The application value, potential ethical risks and governance paths of ChatGPT in the field of education. Sixiang Lilun Jiaoyu, (4), 26–32.
11. Georgiou, K. (2025). ChatGPT produces more “lazy” thinkers: Evidence of cognitive engagement decline. Preprint. arXiv:2507.00181.
12. Ghafouri, M. (2024). ChatGPT: The catalyst for teacher–student rapport and grit development in L2 class. System, 120, Article 103209. https://doi.org/10.1016/j.system.2023.103209
13. Guo, W., Wang, J., Li, N., & Wang, L. (2025). The impact of teacher emotional support on learning engagement among college students mediated by academic self-efficacy and academic resilience. Scientific Reports, 15, Article 3670. https://doi.org/10.1038/s41598-025-88187-x
14. Jiang, Y., & Liu, Y. (2026). Development and validation of Human–Computer Collaborative Classroom Second Language Learning Engagement Scale. Behavioral Sciences, 16(1), Article 46. https://doi.org/10.3390/bs16010046
15. Khajavy, G. H. (2021). Modeling the relations between foreign language engagement, emotions, grit and reading achievement. In P. Hiver, A. H. Al-Hoorie, & S. Mercer (Eds.), Student engagement in the language classroom (pp. 241–259). Multilingual Matters.
16. Kim, J., Yu, S., Detrick, R., & Li, N. (2025). Exploring students’ perspectives on generative AI-assisted academic writing. Education and Information Technologies, 30(1), 1265–1300. https://doi.org/10.1007/s10639-024-12878-7
17. Kuh, G. D. (2001). Assessing what really matters to student learning. Change, 33(3), 10–17. https://doi.org/10.1080/00091380109601795
18. Li, Y., Zhou, X., & Chiu, T. K. (2025). Systematic review on artificial intelligence chatbots and ChatGPT for language learning and research from self-determination theory. Interactive Learning Environments, 33(4), 1850–1864. https://doi.org/10.1080/10494820.2024.2400090
19. Lu, Q., Yao, Y., Xiao, L., Zhu, X., & Yin, H. (2026). Exploring the impact of a GenAI-supported feedback practice on student feedback literacy in L2 writing. Computer Assisted Language Learning. Advance online publication. https://doi.org/10.1080/09588221.2025.2605541
20. Ma, R., & Xu, J. (2024). Constructing and exploring an intelligent teaching model for international Chinese writing. Yuyan Jiaoxue Yu Yanjiu, (2), 14–26.
21. Muñoz Muñoz, B. C., Nassaji, H., & Bello Carrillo, F. I. (2025). ChatGPT-generated versus human direct corrective feedback on L2 writing. System, 134, Article 103805. https://doi.org/10.1016/j.system.2025.103805
22. Oluwaseyi, O. A., Sumitha, R., Ling, T. C. N., Lilian, A., & Niyi, A. C. (2024). Investigating students’ motivation and online learning engagement through the lens of self-determination theory. Journal of

Applied Research in Higher Education, 16(5), 1–18. https://doi.org/10.1108/JARHE-01-2024-0019

23. Ou, Z., Liu, Y., Hao, J., & Yu, F. (2024). Interpreting generative AI policies from an international perspective. Qinghai Minzu Daxue Xuebao, (3), 145–158.
24. Ragolane, M., Patel, S., & Salikram, P. (2024). AI versus human graders: Assessing the role of large language models in higher education. Asian Journal of Education and Social Studies, 50(10), 244–263. https://doi.org/10.9734/ajess/2024/v50i101616
25. Ren, W., Liu, Y., & Xie, Y. (2024). A comparative study of ChatGPT and teacher feedback in English writing instruction. Waiyu Jiaoxue Lilun Yu Shijian, (4), 11–20.
26. Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist, 55(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68
27. Sadoughi, M., Hejazi, S. Y., & Lou, N. M. (2023). How do growth mindsets contribute to academic engagement in L2 classes? Social Psychology of Education, 26(1), 141–170. https://doi.org/10.1007/s11218-022-09740-8
28. Shan, Z., Song, Z., Jiang, X., Chen, W., & Chen, L. (2025). Complementing but not replacing: Comparing the impacts of GPT-4 and native-speaker interaction on Chinese L2 writing outcomes. Behavioral Sciences, 15(4), Article 540. https://doi.org/10.3390/bs15040540
29. Shi, H., Chai, C. S., Zhou, S., & Aubrey, S. (2025). Comparing the effects of ChatGPT and automated writing evaluation on students' writing and ideal L2 writing self. Computer Assisted Language Learning. Advance online publication. https://doi.org/10.1080/09588221.2025.2454541
30. Tang, Q. (2024). Exploring the application of generative AI in TPRS international Chinese language teaching practice: A case study of international students with elementary Chinese proficiency. Eurasia Journal of Science and Technology, 6(5), 39–42. https://doi.org/10.61784/ejst3034
31. Teng, M. F. (2025). Understanding EFL student writers' metacognitive awareness in utilizing ChatGPT. System, 135, Article 103848. https://doi.org/10.1016/j.system.2025.103848
32. Wang, W., & Zou, M. M. (2026). Unveiling the role of L2 writing feedback engagement in ChatGPT-mediated language learning environment: Teacher support, L2 motivation, and emotions as predictors. European Journal of Education, 61(2), Article e70584. https://doi.org/10.1111/ejed.70584
33. Wang, Y., & Che, P. (2026). Adapting, translating, and validating a student engagement questionnaire in Chinese EFL reading context: A quantitative approach. Language Testing in Asia, 16, Article 35. https://doi.org/10.1186/s40468-025-00421-5
34. Wang, Y. (2024). Cognitive and sociocultural dynamics of self-regulated use of machine translation and generative AI tools in academic EFL writing. System, 126, Article 103505. https://doi.org/10.1016/j.system.2024.103505
35. Wiboolyasarin, W., Wiboolyasarin, K., Suwanwihok, K., Jinowat, N., & Muenjanchoey, R. (2024). Synergizing collaborative writing and AI feedback: An investigation into enhancing L2 writing

proficiency in wiki-based environments. Computers and Education: Artificial Intelligence, 6, Article 100228. https://doi.org/10.1016/j.caeai.2024.100228

36. Wu, Z. (2024). An empirical study on the impact of machine translation tools on English learners' written language proficiency. Waiyu Daokan, (5), 88–96.
37. Xing, W., & Teng, M. F. (2026). Exploring the role of EFL teachers' interpersonal behaviours in students' behavioural, cognitive, and emotional engagement with GenAI: A PLS–SEM approach. European Journal of Education, 61(1), Article e70439. https://doi.org/10.1111/ejed.70439
38. Xu, Y., Yuan, J., Huang, M., & Chen, J. (2025). A study on college students' English learning engagement in blended teaching mode. Dangdai Waiyu Yanjiu, (1), 112–124.
39. Yan, D., & Zhang, S. (2024). L2 writer engagement with automated written corrective feedback provided by ChatGPT: A mixed-method multiple case study. Humanities and Social Sciences Communications, 11, Article 1086. https://doi.org/10.1057/s41599-024-03543-y
40. Yang, C., Li, R., & Yang, L. (2025). Revisiting trends in GenAI-assisted second language writing: Retrospect and prospect. Journal of Educational Computing Research. Advance online publication. https://doi.org/10.1177/07356331251367309
41. Yao, S., & Wang, J. (2024). Applications of interactional linguistics in Chinese L2 instruction. Huawen Jiaoxue Yu Yanjiu, (1), 34–45.
42. Zai, F., & Zhou, X. (2026). The impact of AI-assisted learning on the agency of foreign language learners: A meta-analysis. Behavioral Sciences, 16(3), Article 379. https://doi.org/10.3390/bs16030379
43. Zare, J., Al-Issa, A., & Ranjbaran Madiseh, F. (2025). Interacting with ChatGPT in essay writing: A study of L2 learners' task motivation. ReCALL, FirstView, 1–18. https://doi.org/10.1017/S0958344025000035
44. Zhang, Z., Aubrey, S., Huang, X., & Chiu, T. K. F. (2025). The role of generative AI and hybrid feedback in improving L2 writing skills: A comparative study. Innovation in Language Learning and Teaching. Advance online publication. https://doi.org/10.1080/17501229.2025.2503890

Figures

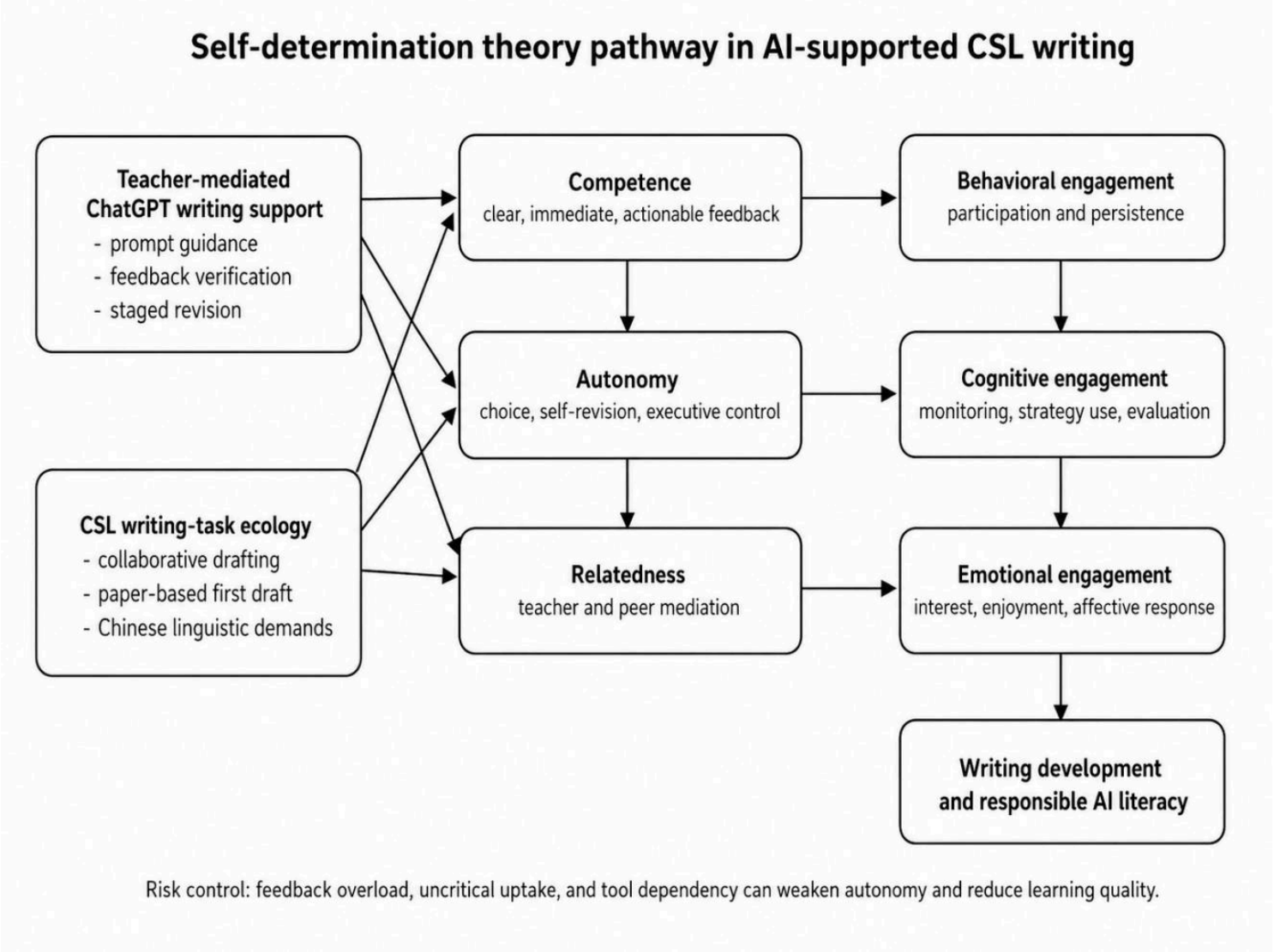


Figure 1

Self-determination theory pathway in AI-supported CSL writing. The framework links teacher-mediated ChatGPT support and CSL writing-task ecology to three basic psychological needs (competence, autonomy, relatedness) and three engagement dimensions (behavioral, cognitive, emotional), ultimately contributing to writing development and responsible AI literacy.

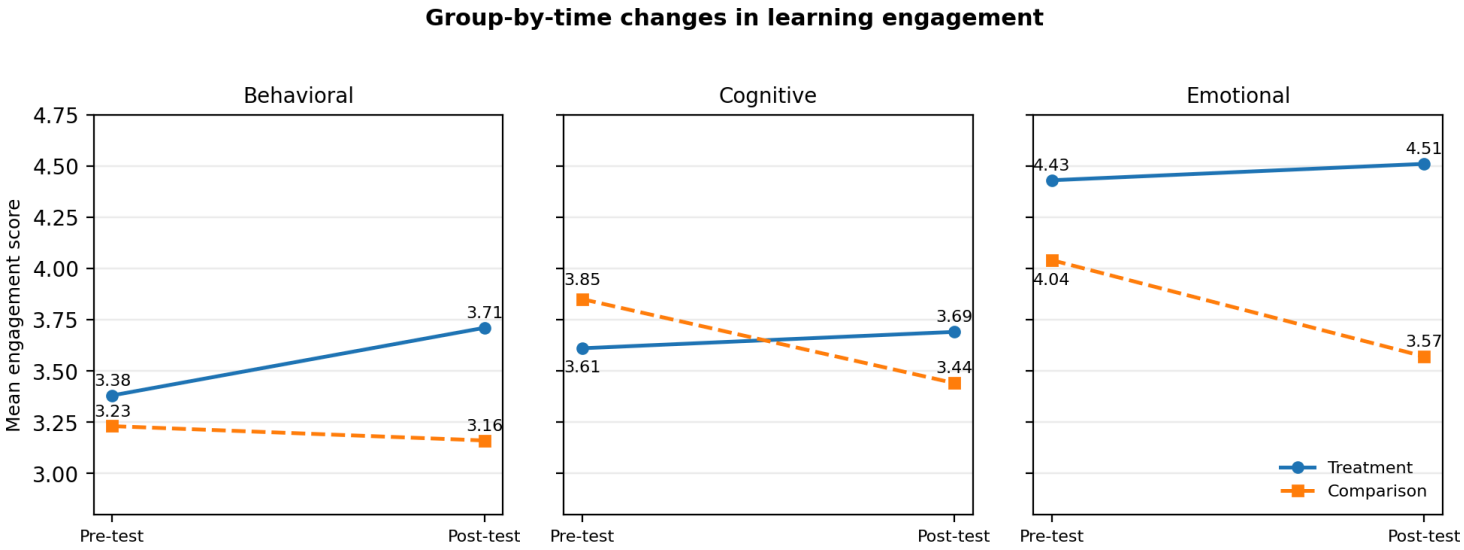


Figure 2

Group-by-time changes in behavioral, cognitive, and emotional engagement.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- 0603checkedsubmissionpackage.zip