

BRIDGING AI LITERACY AND SELF-PERCEIVED CRITICAL WRITING PERFORMANCE: THE MEDIATING ROLE OF COLLABORATIVE INTERACTION AMONG EFL STUDENTS

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ABSTRACT

The rapid integration of artificial intelligence (AI) into academic writing has influenced EFL learning practices; however, empirical understanding of how students' AI literacy translates into meaningful collaboration and critical writing development remains limited and inconclusive. This study aims to explore the structural relationships among students' AI literacy, collaborative interaction quality, and self-perceived critical writing performance within an AI-supported EFL writing context. Adopting a quantitative survey design, data were collected from 282 EFL students enrolled in public universities in the Surakarta municipality using purposive sampling. A five-point Likert-scale questionnaire was employed to measure AI literacy, collaborative interaction quality, and perceived critical writing performance. Data were analyzed using structural modeling approach (SEM-PLS), including reliability and validity assessment, bootstrapped mediation analysis, and correlational-based path analysis. This study reveals that while AI literacy has a significant direct impact on self-perceived critical writing performance, it does not automatically foster collaborative interaction among EFL learners. However, collaborative interaction emerged as a predictor of students' self-perceived critical writing performance and a critical mediator that significantly supports the effect of AI literacy on performance outcomes. These findings suggest that the benefits of technological proficiency are best realized when channeled through social-collaborative frameworks, suggesting the need for pedagogies that integrate individual AI competence with peer-based critical engagement. This study advances an exploratory model on the conditional role of collaboration in AI-supported writing. Pedagogically, it calls out the need for instructional scaffolding to complement AI literacy development in EFL writing classrooms.

Keywords: AI literacy, collaborative interaction, critical writing, EFL learners

INTRODUCTION

The rapid advancement of artificial intelligence (AI) technologies in higher education has fundamentally reshaped how students learn, interact, and develop academic texts, particularly in English as a Foreign Language (EFL) contexts. AI-powered tools, including generative

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writing assistants, automated feedback systems, and language-enhancement applications, are increasingly embedded in students' academic writing practices (Herda et al., 2025; Kim et al., 2025; Wang, 2025). Their pedagogical value, however, depends not simply on access to these technologies but on learners' ability to understand, evaluate, and use them critically and responsibly. This capacity is commonly conceptualized as AI literacy, encompassing learners' functional, critical, and ethical competencies in interacting with AI systems (Bećirović et al., 2025; Chiu et al., 2024; Laupichler et al., 2022). In EFL writing, AI literacy is particularly important because students may use AI to generate ideas, improve language accuracy, organize arguments, and revise texts. At the same time, uncritical reliance on AI may reduce cognitive engagement and weaken students' control over the writing process (Fan et al., 2025; Nguyen et al., 2024; Zhai et al., 2024). Thus, the increasing integration of AI into EFL writing raises an important pedagogical question concerning how students' AI literacy relates to their ability to engage critically with academic writing tasks.

Previous studies have shown growing evidence that AI literacy can shape students' academic writing experiences and outcomes. AI-literate learners are better positioned to evaluate AI-generated information, distinguish useful suggestions from inaccurate or inappropriate content, and integrate AI assistance into their writing processes strategically (Bećirović et al., 2025; Fauziah & Ambarwati, 2025; Uygun, 2026). Research on AI-assisted writing has also reported benefits in areas such as writing efficacy, language precision, content development, and learner autonomy (Chen & Gong, 2025; Lai, 2025; Mahapatra, 2024; Zhao, 2025). Nevertheless, critical writing requires more than linguistic improvement or efficient text production. It involves formulating defensible claims, evaluating evidence, considering alternative perspectives, organizing arguments coherently, and revising ideas reflectively (Canagarajah, 2012; Dong & Chang, 2023; Esmail et al., 2022). AI literacy may therefore be particularly relevant to students' self-perceived critical writing performance, because students who understand the capabilities and limitations of AI may be better able to use AI-generated suggestions as resources for reasoning rather than as substitutes for their own thinking. However, the relationship between AI literacy and students' perceived critical writing performance cannot necessarily be understood as an exclusively individual or technological process.

One important factor that may explain this relationship is the quality of students' collaborative interaction during writing. Collaborative writing research has consistently demonstrated that interaction among learners can facilitate idea negotiation, peer feedback, cognitive conflict, and mutual scaffolding, thereby supporting writing development and critical thinking (Saksopin et al., 2025; Shulgina et al., 2024; Taufiquilloh et al., 2024). High-quality collaborative interaction involves active participation, constructive questioning, critical discussion, coordination, and shared responsibility for textual decisions. These processes are particularly relevant in AI-supported writing because students must not only evaluate their peers' ideas but also collectively assess, modify, accept, or reject AI-generated suggestions (Darmawansah et al., 2025; Hu et al., 2025; Ruiz-Rojas et al., 2024). Recent research suggests that AI-mediated collaborative environments can strengthen engagement and argumentation when learners use AI as a cognitive resource within socially organized learning activities (Aslan et al., 2025; Msambwa et al., 2025). Accordingly, collaborative interaction may constitute an important social mechanism through which students develop their capacity to engage critically with writing tasks.

The relationship between AI literacy and collaborative interaction, however, is less straightforward. In principle, students with stronger AI literacy should be better able to understand AI capabilities and limitations, communicate appropriate strategies for AI use, and contribute meaningfully to collective decision-making. AI literacy may therefore provide learners with the knowledge and confidence required to participate productively in AI-supported group activities (Chiu et al., 2024; Laupichler et al., 2022). Yet emerging evidence also suggests that AI may facilitate more individualized forms of learning and potentially reduce students' reliance on peers when they perceive AI tools as sufficient for completing academic tasks (Fan et al., 2025; Msambwa et al., 2025). Similarly, overreliance on AI may

weaken cognitive engagement and diminish opportunities for meaningful peer interaction (Nguyen et al., 2024; Zhai et al., 2024). These contrasting possibilities indicate that AI literacy does not necessarily translate automatically into stronger collaboration. Rather, its relationship with collaborative interaction may depend on how learners use AI within socially organized writing activities.

The existing literature reveals several unresolved issues. First, research on AI in EFL writing has frequently emphasized tool effectiveness, writing improvement, or learner perceptions, while comparatively less attention has been given to AI literacy as a learner-level capability that may shape both individual and social learning processes (Arseven & Bal, 2025; Irish et al., 2025). Second, collaborative writing research has established the importance of peer interaction for writing development, but the role of collaboration within AI-supported writing environments remains comparatively underexplored (Hu et al., 2025; Msambwa et al., 2025; Shulgina et al., 2024). Third, existing findings do not provide a consistent explanation of whether AI literacy directly contributes to collaborative interaction or whether its benefits for writing are primarily realized through social and cognitive engagement. The literature therefore leaves an important empirical question unresolved: does AI literacy independently contribute to students' self-perceived critical writing performance, does it facilitate the collaborative interaction through which such performance may develop, or do both processes operate simultaneously? Addressing this question requires a framework that considers both the technological fit between learners and AI-supported writing tasks and the social processes through which learning occurs.

The two complementary theoretical perspectives provide a basis for understanding these relationships. Task-Technology Fit (TTF) provides a technological perspective by proposing that performance is enhanced when the capabilities of a technology correspond to the requirements of the task. Applied to AI-supported EFL writing, students with stronger AI literacy may be better able to identify appropriate AI functions and apply them to cognitively demanding writing activities, such as brainstorming, organizing arguments, evaluating evidence, and revising texts. AI literacy may consequently enhance students' perceived ability to perform critical writing tasks because they can use AI capabilities more appropriately and strategically. At the same time, Social Constructivism emphasizes that learning develops through interaction, dialogue, negotiation, and collaborative meaning-making (McKinley, 2015). From this perspective, AI literacy alone is insufficient to explain writing development because critical writing is also constructed through interaction with peers. Collaborative interaction provides opportunities for learners to question ideas, negotiate interpretations, evaluate AI-generated suggestions, and collectively refine arguments (Alsahil, 2024; Stell & Iwashita, 2024). Integrating these perspectives therefore allows the present study to conceptualize AI literacy as an individual technological capability while positioning collaborative interaction as the social process through which this capability may contribute to perceived writing performance.

Despite the increasing research on AI-assisted writing, empirical evidence integrating these technological and social dimensions remains limited. Previous studies have generally examined AI literacy, collaborative writing, and writing outcomes as relatively separate areas of inquiry, while few studies have tested their structural relationships within a single explanatory model. In particular, the potential mediating role of collaborative interaction between AI literacy and students' self-perceived critical writing performance has received insufficient empirical attention. This gap is especially relevant in EFL higher education, where students simultaneously face linguistic, cognitive, and technological demands when producing academic texts. The present study addresses this gap by integrating AI literacy, collaborative interaction quality, and self-perceived critical writing performance into a mediation model. The study consequently contributes to the literature by moving beyond the assumption that technological competence directly yields better writing outcomes and by examining whether the social-collaborative process provides an important mechanism linking AI literacy with perceived critical writing performance.

This study aims to examine the structural relationships among students' AI literacy, collaborative interaction quality, and self-perceived critical writing performance in AI-supported EFL writing contexts. Specifically, it investigates whether AI literacy directly predicts students' self-perceived critical writing performance, whether AI literacy predicts the quality of collaborative interaction, whether collaborative interaction predicts self-perceived critical writing performance, and whether collaborative interaction mediates the relationship between AI literacy and self-perceived critical writing performance. Based on the integrated theoretical and empirical arguments above, the following hypotheses are proposed:

H₁: Students' AI literacy has a significant positive effect on their self-perceived critical writing performance.

H₂: Students' AI literacy has a significant positive effect on the quality of collaborative interaction in AI-supported writing tasks.

H₃: The quality of collaborative interaction has a significant positive effect on students' self-perceived critical writing performance.

Mediation theory suggests that the relationship between an antecedent variable and an outcome can be better understood by examining an intervening mechanism through which the antecedent influences the outcome. In educational research, mediating variables are particularly relevant when the effect of an individual capability is expected to operate through learners' engagement in specific cognitive or social processes. In the present context, AI literacy may provide students with the knowledge and competence to use AI tools effectively, but its contribution to writing development may depend on how this competence is enacted through interaction with peers. Collaborative interaction can provide the social and cognitive mechanism through which AI-literate learners discuss, evaluate, negotiate, and refine AI-generated suggestions, subsequently supporting their self-perceived critical writing performance. Thus, collaborative interaction is theoretically positioned not merely as a parallel predictor but as an explanatory mechanism connecting AI literacy with writing outcomes. Accordingly, the following mediation hypothesis is proposed:

H₄: The relationship between AI literacy and self-perceived critical writing performance is significantly mediated by the quality of collaborative interaction.

Figure 1 demonstrates the model, presenting potential connection among variables examined through this quantitative survey research.

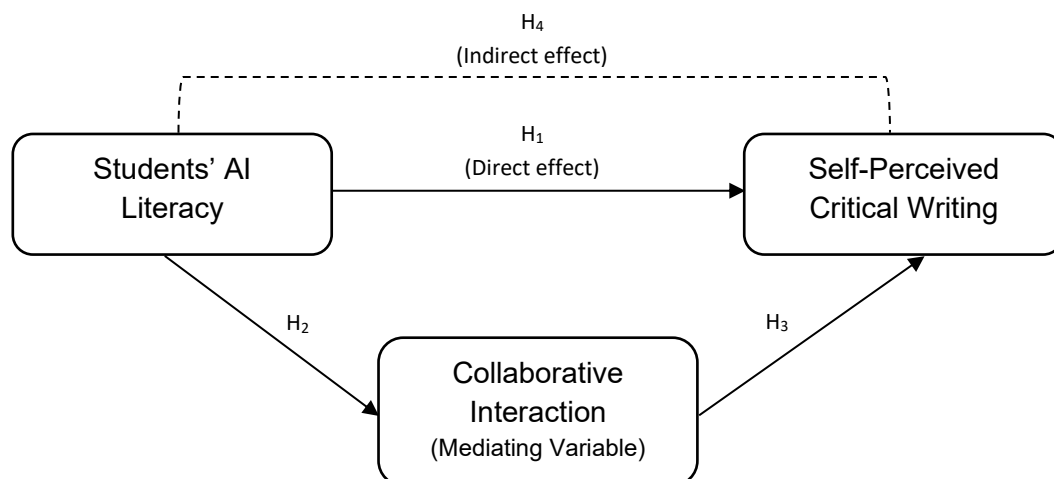


Figure 1. Research Model

METHODS

This study adopted a quantitative survey research design to examine the structural relationships among students' AI literacy, collaborative interaction quality, and critical writing self-perception within an EFL context. A survey approach was deemed appropriate because this study aimed to capture latent psychological and behavioral constructs that are best measured through self-reported perceptions across a relatively large population. Moreover, the hypothesized model involved multiple interrelated variables and mediation effects, which necessitated the collection of standardized data suitable for multivariate statistical analysis. Survey-based designs are particularly effective in educational research for identifying patterns, testing theoretical models, and generalizing findings within defined contexts. In line with the study's explanatory purpose, the survey method enabled the systematic examination of direct and indirect effects among variables, thereby providing empirical support for the proposed conceptual framework linking AI literacy, collaboration quality, and critical writing performance among EFL learners.

The study was conducted at public universities located in the Surakarta municipality, Central Java, Indonesia, where English is taught as a foreign language. The participants comprised 282 undergraduate EFL students selected using purposive sampling. Purposive sampling was chosen because the study required participants with specific prior experiences that were directly relevant to the research variables, particularly experience with AI-assisted writing and collaborative writing activities. A probability sampling approach was considered less appropriate because the study did not seek to represent all university students, but specifically targeted EFL learners who possessed sufficient experience to provide informed responses concerning AI literacy, collaborative interaction, and critical writing. Three empirical criteria guided participant selection. First, students were required to be enrolled in academic writing or advanced writing courses to ensure adequate exposure to critical writing tasks. Second, participants had to report prior experience using AI-assisted writing tools (e.g., generative AI or automated feedback systems) in academic contexts. Third, students were required to have participated in collaborative writing activities as part of their coursework. These criteria ensured that respondents possessed the experiential background necessary to provide relevant and informed responses to the research instruments.

Data were collected using a structured questionnaire consisting of three main scales measured on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The Students' AI Literacy Scale measured functional, critical, and ethical dimensions of AI use in academic writing contexts, adapted from Bećirović et al. (2025) and Wang et al. (2023). The Collaborative Interaction Quality Scale assessed students' perceptions of participation, cognitive engagement, and coordination during AI-supported collaborative writing tasks (Colli et al., 2019). In addition, the Critical Writing Self-Perception scale examined learners' perceived ability to develop arguments, evaluate alternative viewpoints, and revise writing critically (Cequeña, 2020). The completed questionnaire items are presented in Appendix 1. The questionnaire was administered online to facilitate accessibility and anonymity. Prior to full deployment, the instrument underwent expert review to ensure content validity and linguistic clarity. Participation was voluntary, and informed consent was obtained from all respondents in accordance with ethical research standards.

The collected data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with a two-stage analytical procedure involving measurement and structural model assessment. PLS-SEM was selected due to its suitability for predictive research, complex mediation models, and non-normal data distributions. Measurement model evaluation involved examining indicator loadings, composite reliability, and average variance extracted (AVE) to establish internal consistency and convergent validity. Discriminant validity was assessed using the Fornell–Larcker criterion and the Heterotrait–Monotrait (HTMT) ratio, ensuring adequate construct distinctiveness. Structural model assessment included evaluating path coefficients, and bootstrapped significance testing to examine direct and

indirect effects. Mediation was tested using bootstrapped confidence intervals to determine the significance of the indirect path through collaborative interaction quality.

FINDINGS AND DISCUSSION

Respondent Profile

Table 1 presents the demographic profile of the 282 respondents who participated in this study. In terms of gender, the sample was relatively balanced, with female students constituting a slight majority (56.38%), while male students accounted for 43.62%. The respondents were predominantly young adults, with most falling within the 22–24 (25.18%) and 28–30 (29.43%) age ranges, followed by those aged 19–21 (20.57%) and 25–27 (20.21%), indicating a diverse age distribution across undergraduate and graduate levels. With regard to academic standing, third-year undergraduate students formed the largest group (32.27%), followed by second-year students (26.60%), first-year students (15.25%), master's degree students (14.54%), and fourth-year students (11.35%). Most participants were enrolled in English Language Education programs (74.11%), while the remaining respondents came from Linguistics and Literary Studies (25.89%), confirming the relevance of the sample to the EFL context. Concerning experience with AI tools for writing, the majority reported moderate to extended exposure, with 7–9 months of use being the most common (34.75%), followed by more than one year (21.63%). Finally, in terms of collaborative learning experience, none of the respondents reported having no experience, while a substantial proportion engaged in collaborative writing either occasionally (28.72%) or frequently (35.82%), suggesting that most participants were familiar with collaborative learning practices examined in this study.

Table 1. Respondent Profile (N = 282)

Description	Category	Number	Percentage
Gender	Male	123	43.62%
	Female	159	56.38%
Age	19-21	58	20.57%
	22-24	71	25.18%
	25-27	57	20.21%
	28-30	83	29.43%
	≥ 31	13	4.61%
Academic year (semester)	First year student	43	15.25%
	Second year student	75	26.60%
	Third year student	91	32.27%
	Fourth year student	32	11.35%
	Master's degree	41	14.54%
Study program	English language education	209	74.11%
	Linguistics and literary studies	73	25.89%
Experience using AI Tools for Writing	3-6 months	72	25.53%
	7-9 months	98	34.75%
	10-12 months	51	18.09%
	More than 1 year	61	21.63%
Experience with collaborative learning	Never	0	0.00%
	Occasionally (3-5 times in a semester)	81	28.72%
	Frequently (≥ 6 times in a semester)	101	35.82%

Convergent Validity and Reliability

The measurement model presented in Table 2 demonstrated satisfactory convergent validity and internal consistency reliability. All indicator loadings exceeded the recommended

threshold of 0.70, indicating strong item reliability. Average Variance Extracted (AVE) values for AI literacy (0.64), collaborative interaction (0.62), and self-perceived critical writing (0.66) exceeded the minimum criterion of 0.50, confirming adequate convergent validity. Cronbach's alpha values ranged from 0.88 to 0.91, while composite reliability values ranged from 0.91 to 0.93, indicating high internal consistency. Furthermore, all variance inflation factor (VIF) values were below 3.0, suggesting the absence of multicollinearity concerns.

Table 2. Convergent Validity and Reliability (Measurement Model)

Measure	Factor Loading	VIF	AVE	Cronbach Alpha's	Composite Reliability
AI 1	0.82	1.91	0.64	0.89	0.92
AI 2	0.84	2.03			
AI 3	0.79	1.88			
AI 4	0.81	1.95			
AI 5	0.76	1.72			
AI 6	0.85	2.11			
AI 7	0.83	1.97			
AI 8	0.78	1.81			
AI 9	0.80	1.89			
AI 10	0.82	1.94			
AI 11	0.77	1.76			
AI 12	0.75	1.69			
CI 1	0.79	1.84	0.62	0.91	0.93
CI 2	0.81	1.93			
CI 3	0.83	2.01			
CI 4	0.77	1.79			
CI 5	0.82	1.96			
CI 6	0.80	1.87			
CI 7	0.85	2.08			
CI 8	0.78	1.82			
CI 9	0.81	1.91			
CI 10	0.76	1.75			
CI 11	0.79	1.88			
CI 12	0.74	1.68			
CW 1	0.83	1.92	0.66	0.88	0.91
CW 2	0.79	1.85			
CW 3	0.82	1.94			
CW 4	0.77	1.78			
CW 5	0.81	1.89			
CW 6	0.85	2.03			
CW 7	0.76	1.71			
CW 8	0.80	1.86			

Note: AI = AI Literacy; CI = Collaborative Interaction; CW = Self-perceived Critical Writing

Discriminant validity was assessed using the Fornell–Larcker criterion. As shown in Table 3, the square root of the Average Variance Extracted (AVE) for each construct was greater than its correlations with other constructs. Specifically, the square root of AVE for AI literacy (0.80), collaborative interaction (0.79), and self-perceived critical writing (0.81) exceeded the corresponding inter-construct correlations. These results confirm that each construct is empirically distinct and that discriminant validity is adequately established.

Table 3. Fornell-Larcker Criterion

Construct	AI Literacy	Collaborative Interaction	Critical Writing Performance
AI Literacy	0.80		

Collaborative Interaction	-0.03	0.79	
Self-perceived Critical Writing	0.09	0.08	0.81

Note: Diagonal values (bold) represent the square root of AVE; off-diagonal values represent inter-construct correlations.

Discriminant validity was further examined using Heterotrait-Monotrait Ratio (HTMT). As shown in Table 4, all HTMT values were well below the conservative threshold of 0.85, ranging from 0.08 to 0.65. These findings provide strong evidence that the constructs exhibit adequate discriminant validity and that multicollinearity between latent variables is not a concern. The low HTMT ratios suggest that AI literacy, collaborative interaction, and self-perceived critical writing represent conceptually and empirically distinct constructs, despite being theoretically related.

Table 4. Heterotrait-Monotrait Ratio (HTMT)

Construct	AI Literacy	Collaborative Interaction	Critical Writing Performance
AI Literacy	-		
Collaborative Interaction	0.08	-	
Self-perceived Critical Writing	0.29	0.65	-

Hypotheses Testing Results

Based on the structural model analysis using SEM-PLS, the results provide clear understanding of the factors influencing EFL students' self-perceived critical writing. As depicted in Table 5, AI Literacy was found to have a statistically significant but relatively small positive association to Self-perceived Critical Writing ($\beta = 0.098$, $p = 0.037$), supporting H₁. However, H₂ was rejected, as AI Literacy did not significantly influence Collaborative Interaction ($\beta = -0.022$, $p = 0.639$). Interestingly, Collaborative Interaction itself emerged as a predictor of Self-perceived Critical Writing ($\beta = 0.112$, $p = 0.000$), supporting H₃. Most notably, the results confirm the mediating role of Collaborative Interaction (H₄), showing a significant indirect path from AI Literacy to Self-perceived Critical Writing performance ($\beta = 0.146$, $p = 0.001$). This suggests that while literacy alone aids performance, its impact is significantly supported when filtered through high-quality collaborative engagement among students.

Table 5. Hypotheses Testing (Structural Model)

Hypothesis	Path	β (Beta)	t-value	p-value	Decision
H ₁	AI Literacy → Self-perceived Critical Writing	0.098	1.49	0.037	Supported
H ₂	AI Literacy → Collaborative Interaction	-0.022	0.47	0.639	Not supported
H ₃	Collaborative Interaction → Self-perceived Critical Writing	0.112	1.33	0.000	Supported
H ₄	AI Literacy → Collaborative Interaction → Critical Writing	0.146	1.71	0.001	Supported

The structural model analysis reveals a complex relationship between the studied variables. Most notably, AI literacy exerts a significant direct influence on self-perceived critical

writing performance (H_1), confirming that technical proficiency with AI tools translates into better academic writing output. While AI literacy failed to directly foster collaborative interaction (H_2), the quality of such interaction proved to be a predictor of writing success (H_3). The most critical revelation is the support for H_4 , which establishes collaborative interaction as a mediator in the relationship between AI literacy and self-perceived critical writing performance. This suggests that the benefits of AI literacy are not purely individualistic; rather, they are channeled through social and peer-to-peer engagement to develop better critical writing results. Collectively, the model explains a portion of the variance in EFL writing outcomes, indicating that both technological competence and social-collaborative processes are essential for success in AI-enhanced language learning environments.

The rejection of H_2 alongside the support for H_4 presents a fascinating statistical and pedagogical paradox. The non-significant relationship between AI literacy and collaborative interaction suggests that AI literacy alone may not be sufficient to ensure greater collaborative engagement. However, the support for H_4 implies that the relationship between AI literacy and writing performance may be strengthened when AI literacy is accompanied by productive collaborative interaction. In this mediation model, the findings indicate that collaborative interaction may represent an important social context in which AI literacy is associated with perceived writing performance (Er et al., 2025). It shows that AI literacy is a necessary but insufficient condition for enhanced collaboration on its own (Li et al., 2025; Teng & Yue, 2023). It requires a structured collaborative environment to unlock its full potential, refining raw AI output into refined critical discourse through peer feedback and collective negotiation of meaning.

The support for H_1 aligns with the Task-Technology Fit (TTF) theory, which posits that performance enhances when a technological tool's capabilities match the requirements of the task. In this context, students with higher AI literacy are better equipped to navigate the complexities of critical writing, such as argumentation and evidence synthesis, by leveraging AI for brainstorming and structural refinement. This finding is consistent with previous research which indicates that digital literacy is a foundational predictor of academic achievement in technology-mediated EFL settings (Bećirović et al., 2025; Wang et al., 2025). Theoretically, this direct path supports the idea that AI literacy is not merely a technical skill but a cognitive asset that assists EFL learners in overcoming linguistic barriers, allowing them to focus more deeply on the critical aspects of their writing rather than just basic grammar or vocabulary.

The positive association between collaborative interaction and self-perceived critical writing performance (H_3) is consistent with Vygotsky's Social Constructivism and the concept of the Zone of Proximal Development (ZPD). Collaborative interaction allows students to engage in scaffolding, in which they can address individual linguistic limitations through peer dialogue (Colli et al., 2019; Darmawansah et al., 2025). In this study, collaborative interaction was positively associated with self-perceived critical writing performance ($\beta = 0.112$, $p < .001$), although the relatively small coefficient indicates that the magnitude of this association should be interpreted cautiously. This finding is consistent with previous EFL research demonstrating that peer feedback and collaborative writing can support students' writing development. In an AI-supported environment, such interaction may also provide opportunities for students to critically evaluate AI-generated suggestions and negotiate meaning with peers.

These findings support and extend previous research in the field of Computer-Assisted Language Learning (CALL). Consistent with earlier studies (Boillos & Idoiaga, 2025; Chan & Tsi, 2024; Eang et al., 2025), this research confirms that technology (AI) enhances writing outcomes when used by literate users. However, it contrasts with some "techno-optimist" views that suggest technology inherently fosters engagement or teamwork. By rejecting H_2 , this study provides a cautionary note that literacy alone does not cure the potential for social withdrawal in digital spaces. This adds a new layer to the literature by highlighting that the "bridge" between literacy and performance is not automatic but is built through deliberate social interaction. Compared to traditional pre-AI collaborative writing studies, these results suggest that the quality of interaction now involves a triadic relationship between the student,

their peers, and the AI agent, representing a shift in how collaborative writing is defined in the modern EFL classroom.

Theoretically, this study contributes to an integrated model of Technology Fit and Social Presence, proving that technical fit must be complemented by social mediation to maximize learning. Practically, for EFL pedagogy, the findings suggest that instructors should not focus solely on teaching students "how to use AI" (literacy) in isolation. Instead, curricula should be designed around AI-mediated collaborative tasks. Educators should encourage "collaborative prompting" and "peer-AI critiquing" sessions, where students use their AI literacy to challenge each other's ideas. This ensures that AI becomes a tool for deepening social and critical engagement rather than a shortcut that bypasses it. Last but not least, the contribution of this study lies in its call for a balanced pedagogical approach: fostering individual AI competence while simultaneously reinforcing the social-collaborative frameworks that turn that competence into critical academic excellence.

CONCLUSION

This exploratory study examined the relationships among AI literacy, collaborative interaction, and students' self-perceived critical writing performance in an AI-supported EFL context. The findings indicate that AI literacy was positively associated with self-perceived critical writing performance, although the magnitude of this relationship was relatively small. Collaborative interaction was also positively associated with self-perceived critical writing performance, while AI literacy was not significantly associated with collaborative interaction. The significant indirect relationship further suggests that collaborative interaction may represent an important mechanism linking AI literacy with students' perceived critical writing performance. These findings highlight the potential importance of combining students' AI-related competencies with opportunities for meaningful peer interaction in AI-supported EFL writing.

The findings should nevertheless be interpreted as exploratory because the study employed a cross-sectional survey design and relied on self-reported measures. Therefore, the observed relationships should not be interpreted as evidence of causal effects or objectively improved writing performance. The findings provide preliminary empirical support for considering both technological and social dimensions when examining AI-supported writing and are broadly consistent with perspectives derived from Task-Technology Fit and Social Constructivism, rather than providing definitive confirmation of these theoretical frameworks. Future research should employ longitudinal, experimental, or performance-based designs, including objective writing assessments and rater-based evaluations, to examine whether the relationships identified in this study are replicated and whether they translate into measurable improvements in students' actual critical writing ability. Future studies may also investigate instructional scaffolding, task design, AI-use patterns, and learner characteristics to further clarify the conditions under which AI-supported collaborative writing may be most beneficial.

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Appendix 1

Questionnaire Items

Section A: Students AI Literacy

- AI 1: I understand what AI writing tools can and cannot do.
- AI 2: I know how to use AI tools to support my writing tasks.
- AI 3: I can write effective prompts to obtain useful responses from AI tools.
- AI 4: I can integrate AI-generated suggestions into my writing process.
- AI 5: I critically evaluate AI-generated content before using it.
- AI 6: I do not automatically trust AI outputs without checking them.
- AI 7: I can identify weaknesses or errors in AI-generated writing.
- AI 8: I use AI tools as support rather than a replacement for my own thinking.
- AI 9: I am aware of ethical issues related to using AI in academic writing.
- AI 10: I use AI tools in ways that follow academic integrity rules.
- AI 11: I revise AI-generated text using my own words and ideas.
- AI 12: I avoid copying AI-generated content directly into my assignments.

Collaborative Interaction Quality

- CI 1: All group members actively participated in the writing task.
- CI 2: I felt encouraged to share my ideas during group discussions.
- CI 3: Group members contributed fairly to the writing process.
- CI 4: Collaboration helped me stay engaged with the writing task.
- CI 5: Group discussions helped me think more critically about the topic.
- CI 6: We discussed and evaluated AI-generated suggestions together.
- CI 7: Group members challenged each other's ideas constructively.
- CI 8: Collaboration improved the quality of our arguments and reasoning.
- CI 9: Our group communicated clearly when using AI tools.
- CI 10: We negotiated which AI-generated ideas should be used or rejected.
- CI 11: The collaboration process was well organized.
- CI 12: AI tools supported, rather than disrupted, our group collaboration.

Critical Writing Performance

- CW 1: I was able to express my ideas clearly in the collaborative writing task.
- CW 2: I considered different viewpoints when developing arguments in the text.
- CW 3: I evaluated the strengths and weaknesses of ideas before including them in my writing.
- CW 4: I revised my writing based on feedback from peers or AI tools.
- CW 5: I was able to support my arguments with relevant reasons or evidence.
- CW 6: I reflected critically on AI-generated suggestions before using them in my writing.
- CW 7: Collaborative discussion helped me refine and clarify my arguments.
- CW 8: The collaborative writing process improved my ability to think critically while writing.