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Enhancing Critical Thinking in EFL Writing Through an AI-Supported Blended Learning Model

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Abstract

This study introduces a novel, critical thinking-oriented blended learning model for English as a Foreign Language (EFL) writing instruction. It addresses the gap in the lack of explicit cognitive guidance for critical thinking in many blended learning models, which often prioritize technology over pedagogy. Grounded in the Paul-Elder Triadic Model and the process-genre approach, this model integrates online, face-to-face, and AI-enhanced learning to cultivate critical thinking within writing development. The model features three hierarchical layers: Goal (critical thinking objectives), Process (pre/in/post-class activities), and Environment (integrating online, offline, and AI components). A quasi-experimental study (N=52 non-English majors, Chinese technical university) compared the model to traditional instruction. Results from the International Critical Thinking Test and TOEFL-based writing assessments indicated significantly improved critical thinking skills in the experimental group, specifically in identifying assumptions, concepts, and inferences, and applying intellectual standards (clarity, relevance, breadth). Writing proficiency improved in both groups, but without significant between-group differences, possibly due to intervention length and the importance of linguistic ability in EFL writing. This study provides empirical evidence for the effectiveness of a theory-driven, AI-enhanced blended learning model specifically designed for critical thinking in EFL writing, extending beyond general approaches by strategically integrating AI to support distinct writing process stages and critical thinking development.

Keywords: Critical Thinking, EFL Writing, AI-Supported Blended Learning Model

Introduction

Blended learning, combining online learning with traditional face-to-face instruction, has emerged as a powerful pedagogical approach in response to the rise of e-learning. Its flexibility, ease of implementation, and capacity to integrate complex multimedia resources have positioned it as a significant trend in educational development (Chen & Hwang, 2020). While research on blended learning has proliferated in recent years, a critical gap remains: many existing models lack explicit cognitive guidance, particularly in the area of critical thinking (Chou et al., 2019). This absence hinders the promotion of deep learning among students. Critical thinking, widely recognized as an essential skill for 21st-century citizens, emphasizes cognitive improvement through analysis, application, and reasoning, ultimately enhancing judgment and decision-making abilities (Liang & Fung, 2021). It has become a driving force in the advancement of knowledge-based societies and is considered a fundamental objective across all educational levels, particularly in higher education. Furthermore, the advent of Artificial Intelligence (AI) in education presents new opportunities to address this gap, offering personalized and adaptive learning experiences that can foster critical thinking skills (Park & Doo, 2024; Wu, 2024). Therefore, integrating critical thinking as a core guiding principle within blended learning frameworks, potentially enhanced by AI applications, is both necessary and valuable to foster deeper learning outcomes.

Within the field of English language instruction, particularly in English as a Foreign Language (EFL) contexts, the cultivation of critical thinking has garnered increasing attention in recent years (Zalani & Yousofi, 2024). While Brown(2004) argues that English courses should not solely focus on linguistic knowledge but also incorporate critical thinking development, and Davidson(1998) highlights the importance of fostering critical thinking in foreign language education, a persistent challenge remains. The phenomenon of "absence of critical thinking" remains a prevalent issue among foreign language learners in China (Wang et al., 2017), underscoring the need for targeted interventions. Given the intrinsic link between writing and thinking, writing courses are ideally positioned as suitable platforms for cultivating critical thinking skills (Yin et al., 2024). With the increasing adoption of blended learning approaches and online teaching platforms in university English writing instruction, some researchers have begun to explore the synergistic potential of these two domains. Online platforms can transcend temporal and spatial limitations, providing more opportunities for discussion, interaction, and feedback, thereby facilitating students' critical thinking development (Chien et al., 2020). However, the integration of AI tools, such as intelligent tutoring systems, automated feedback mechanisms, and personalized learning platforms, offers further potential to enhance these benefits (Park & Doo, 2024; Zou et al., 2023). However, in pedagogical practice, a crucial question persists: how can educators leverage the advantages of AI-enhanced online platforms through effective instructional design to specifically enhance critical thinking in EFL writing instruction? This area remains underexplored.

To address this gap, the present study proposes and evaluates a novel critical thinking-oriented blended learning model for English writing instruction, grounded in established theories related to critical thinking, writing pedagogy, and blended learning, with a specific focus on the integration of AI tools to enhance the learning environment. The study examines the effectiveness of this model through a quasi-experimental instructional experiment. To contribute a novel example of a critical thinking-driven blended learning approach enhanced

by AI, this model offers the potential to provide valuable insights for the innovative design of blended learning in educational settings, specifically within the context of EFL writing.

Literature Review

Critical thinking skills

Research on critical thinking boasts a rich and extensive history, spanning several decades and encompassing diverse perspectives from both domestic and international academic communities (Chou et al., 2019). This sustained inquiry has yielded a substantial body of scholarly work, resulting in the development of several influential theoretical frameworks. Prominent among these are the Cognitive-Affective Dual-Dimensional Model, articulated in the landmark 1990 Delphi Expert Consensus Report; the Elements-Standards-Traits Triadic Model, advanced by Paul and Elder; and the Hierarchical Critical Thinking Model, specifically tailored to the context of foreign language learning by Chinese scholar Wen (2009). While each framework offers unique insights, the present study aligns with the Paul-Elder Triadic Model (2001) due to its conceptual parallels between the model's Elements of Thought and key components of effective English writing, such as perspective, argumentation, and reasoning. Furthermore, the model's clear distinction between Elements of Thinking and Intellectual Standards provides a robust and practical framework for analyzing the objectives of a blended learning intervention aimed at fostering critical thinking.

The Paul-Elder model highlights three interconnected components essential to critical thinking: Elements of Thinking, Intellectual Standards, and Intellectual Traits (Paul & Elder, 2006). The Elements of Thinking include fundamental reasoning structures such as defining purpose, analyzing assumptions, and considering different viewpoints, which help deconstruct complex issues and build strong arguments (Paul & Elder, 2008). The Intellectual Standards—such as Clarity, Accuracy, and Fairness—serve as benchmarks for assessing reasoning quality, ensuring logical and comprehensive thought (Paul & Elder, 2012). For example, an argument may be clear but lack breadth if opposing views are ignored, a concern supported by Arthi & Gandhimathi (2025). Lastly, Intellectual Traits like Intellectual Humility and Fairmindedness are cognitive dispositions developed through the consistent application of these standards, fostering a commitment to intellectual rigor and open-minded engagement with diverse perspectives (Paul & Elder, 2008). Together, these components create a structured approach to refining critical thinking skills.

Central to the Paul-Elder framework is the iterative process of applying Intellectual Standards to the Elements of Thinking. According to Paul and Elder, reasoning begins with a conscious and deliberate identification of the relevant Elements of Thinking within a specific context or problem. These elements must then be rigorously assessed using the Intellectual Standards. This iterative process, when practiced consistently, fosters the development of corresponding Intellectual Traits or cognitive dispositions. In essence, the model emphasizes that critical thinking is not a passive activity but rather an active and ongoing process of self-improvement. Figure 1 illustrates the structure of this triadic model and the interrelationships among its components. At its core, the model delineates three critical dimensions of critical thinking development.

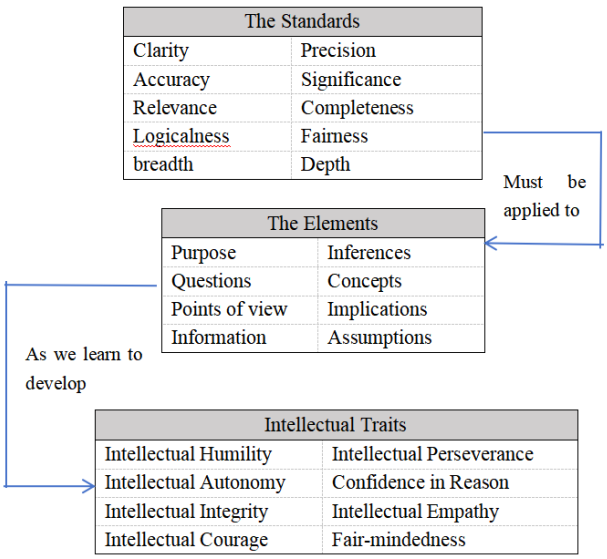

Figure 1. The Paul-Elder Framework for Critical Thinking (Paul-Elder, 2009).

While the Paul-Elder model provides a comprehensive framework for understanding critical thinking, it's important to acknowledge the role of technology, particularly AI, in fostering these skills. AI-powered tools can provide personalized feedback, adaptive learning pathways, and opportunities for collaborative problem-solving, all of which can contribute to the development of critical thinking abilities (Park & Doo, 2024; Wu, 2024). For example, intelligent tutoring systems can guide students through the Elements of Thinking by prompting them to identify the purpose of an argument, analyze the information presented, and evaluate the inferences made (Zou et al., 2023). Similarly, AI-powered writing tools can help students apply Intellectual Standards by providing feedback on the clarity, accuracy, and logic of their writing.

Given that the formation of Intellectual Traits is predicated upon the systematic application of Elements of Thinking and Intellectual Standards, a comprehensive understanding of these intellectual dispositions requires a thorough examination of these foundational components. Therefore, this study primarily focuses on Elements of Thinking and Intellectual Standards as the primary analytical entry points for exploring the theoretical implications of critical thinking development, recognizing the interconnectedness of Intellectual Traits, in blended learning contexts. This focus allows for a more granular and practical analysis of how specific instructional activities and AI tools can target the development of critical thinking skills within the framework of the Paul-Elder model.

Theoretical Approaches to English Writing Instruction

The field of English writing instruction has witnessed a significant evolution over the past several decades, characterized by a shift in pedagogical focus and the emergence of increasingly sophisticated theoretical frameworks. This evolution can be broadly understood as a progression through several distinct stages, transitioning from the traditional product approach to the process approach, then to the genre-based approach, and ultimately to the currently favored process-genre approach. The process-genre approach, as synthesized by Badger and White (2000), represents a culmination of these earlier approaches, integrating their key strengths while addressing their limitations. Central to this approach is the emphasis

on guiding students through carefully sequenced writing tasks that serve specific communicative purposes within clearly defined social contexts. This approach acknowledges the complex interplay between the cognitive processes of writing and the social and rhetorical demands of different genres (Hyland, 2003). Also, this approach is in consonance with the cultivation of critical thinking, stated by Yin et al, 2024.

The process-genre approach rests upon two fundamental, interrelated assumptions that shape both its theoretical underpinnings and its pedagogical implications. First, it posits that writing is inherently linked to social contexts and functions primarily as a communicative activity. This perspective emphasizes that specific genres emerge as responses to recurring social situations, providing writers with tools for effectively navigating these contexts and achieving specific communicative goals (Hyland, 2003). This understanding of writing as a rhetorical act, always situated within a particular context and directed towards a specific audience and purpose, is crucial for developing communicative competence (Cope & Kalantzis, 2000). Moreover, the ability to analyze and adapt to different rhetorical situations is a key aspect of critical thinking (Zalani & Yousofi, 2024).

Second, the process-genre approach recognizes that writing is a complex and recursive cognitive process. Rather than viewing writing as a linear progression towards a finished product, this perspective acknowledges that writers engage in multiple, iterative stages, including planning, drafting, revising, and editing (Flower & Hayes, 1981). Each stage involves distinct cognitive processes, such as generating ideas, organizing information, evaluating arguments, and refining language (Bereiter & Scardamalia, 1987). Effective writing instruction, therefore, must provide scaffolding and support for each of these stages, fostering students' metacognitive awareness of their own writing processes.

Building upon these core assumptions, scholars from both domestic and international academic communities have proposed diverse frameworks for implementing the process-genre approach in writing instruction . While variations exist, these frameworks generally converge on several key stages: model text analysis, guided writing, independent writing, peer editing and revision, and the submission of a final draft (Tribble, 1996; Hyland, 2007). This staged approach allows for a gradual development of writing skills, with each stage building upon the previous one. Since the process-genre approach not only prioritizes the final written product but also considers the context, purpose, and process of writing, it creates a more conducive environment for fostering critical thinking skills. The emphasis on analyzing model texts, engaging in peer review, and revising one's work based on feedback promotes critical reflection and evaluation – key components of critical thinking (Nicol, Thomson, & Breslin, 2014). Recent research by Chien et al. (2020) further highlights the synergistic relationship between collaborative writing activities, such as peer feedback, and the development of critical thinking skills in EFL contexts. Given its emphasis on cognitive engagement through metacognitive activities, contextual awareness, and collaborative learning, this study adopts the process-genre approach as the foundational instructional framework for designing a blended learning model for English writing.

Furthermore, the process-genre approach is particularly well-suited for integration with AI-powered writing tools. These tools can provide support for various stages of the writing process, from brainstorming and outlining to drafting and revising (Wale &Kassahun, 2024).

For example, AI-powered grammar and style checkers can provide immediate feedback on students' writing, helping them to identify and correct errors. AI-based paraphrasing tools can assist students in understanding and avoiding plagiarism (Liu et al., 2013). And AI-driven text analysis tools can help students to analyze model texts and identify the key features of different genres. By providing targeted support and feedback, AI tools can enhance the effectiveness of the process-genre approach and further promote the development of critical thinking skills.

Theoretical Perspectives on Blended Learning

The concept of blended learning, while seemingly straightforward, has been interpreted and operationalized from various perspectives by scholars worldwide, reflecting the diverse contexts and pedagogical goals in which it is applied. At its core, however, blended learning can be broadly defined as:

"A learning approach that delivers the 'appropriate' competencies to the 'appropriate' learners at the 'appropriate' time by applying the 'appropriate' learning technologies that align with the 'appropriate' learning styles, thereby achieving optimal learning outcomes." (Singh, H. & Reed, C.,2018)

This definition, while encompassing the key elements of blended learning, highlights the inherent flexibility and adaptability of the approach. It implies that instructional designers should adopt an inclusive and learner-centered approach to different learning modalities—including, but not limited to, traditional classroom instruction, online learning platforms, and various digital tools—based on the actual teaching needs, learning objectives, and student characteristics. The ultimate goal is to foster higher-order thinking skills and deep learning among students (Garrison & Kanuka, 2004).

Beyond this broad definition, several key principles underpin effective blended learning design. First and foremost, blended learning is not simply about adding technology to a traditional classroom; it represents a fundamental rethinking of instructional design (Graham, 2006). It involves a strategic and purposeful integration of online and face-to-face learning experiences, leveraging the affordances of each modality to create a synergistic and coherent learning environment (Dziuban, Hartman, & Moskal, 2004). This integration should be driven by pedagogical considerations, not by the technology itself (Vaughan, 2007). In other words, the technology should serve the learning objectives, not the other way around.

Furthermore, effective blended learning promotes active learning and student engagement (Means et al., 2013). By providing opportunities for both synchronous and asynchronous interaction, blended learning environments can cater to diverse learning styles and preferences, fostering a more inclusive and personalized learning experience (Chen & Hwang, 2020). For example, online discussion forums can allow students to reflect on their learning and engage in thoughtful discussions with their peers, while face-to-face sessions can provide opportunities for immediate feedback and collaborative problem-solving.

In accordance with this theoretical perspective and the principles of effective blended learning design, this study develops a blended learning model for English writing instruction that is explicitly designed to cultivate students' critical thinking skills. By aligning course

content with pedagogical realities, the study selects appropriate technological tools, specifically Google Docs and Flipgrid, along with exploring the potential of AI-powered tools, to integrate in-class and online learning into a cohesive blended learning framework that supports both writing development and critical thinking cultivation. These tools were chosen for their ease of use, accessibility, and affordances for collaborative writing, peer feedback, and asynchronous discussion, all of which have been shown to be beneficial for promoting critical thinking (Afrilyasanti et al., 2024; Chien et al., 2020; Zou et al., 2023). The integration of these tools is not arbitrary but rather purposeful, designed to enhance specific aspects of the writing process and to provide opportunities for students to engage in critical thinking activities. Moreover, the potential of integrating AI-driven tools for personalized feedback, adaptive learning pathways, and automated assessment is considered within the design of the blended learning environment (Park & Doo, 2024; Wu, 2024).

The integration of these tools is not arbitrary but rather purposeful, designed to enhance specific aspects of the writing process and to provide opportunities for students to engage in critical thinking activities. Moreover, the potential of integrating AI-driven tools for personalized feedback, adaptive learning pathways, and automated assessment is considered within the design of the blended learning environment (Park & Doo, 2024; Wu, 2024). However, the specific ways in which this AI-enhanced, critical thinking-oriented blended learning model impacts both critical thinking skills and writing proficiency, and how students perceive this integrated approach, require empirical investigation.

Given the design and aims of this study, the following research questions are directly answerable by the quasi-experimental design and the data collected:
RQ 1. Does the AI-enhanced, critical thinking-oriented blended learning model significantly improve EFL students' critical thinking skills compared to a traditional instructional approach?
RQ2. Does the AI-enhanced, critical thinking-oriented blended learning model significantly impact EFL students' writing proficiency compared to a traditional instructional approach?
RQ3. Is there an interaction between the scores of students' critical thinking and writing tests and application of different teaching modes?

Research Design

The critical thinking-oriented blended learning model for English writing is structured into three hierarchical layers: the Goal Layer (Top Level), the Core Learning Process Layer (Middle Level), and the Learning Environment Layer (Bottom Level). These layers are visualized as concentric circles, with the Goal Layer at the center, surrounded by the Core Learning Process Layer, and finally encompassed by the Learning Environment Layer. This structure emphasizes the centrality of critical thinking objectives and their influence on all aspects of the model. Among these, the Goal Layer serves as the foundation for instructional design, ensuring that students engage in structured learning processes that foster critical thinking development.

The Instructional Design

At the core of this model is the premise that the development of critical thinking is not determined solely by the final written product but by the cognitive behaviors exhibited throughout the writing process. By guiding students through a carefully designed sequence of learning activities, the model enables them to engage in reasoning, analysis, and

evaluation, ultimately strengthening their critical thinking abilities. The Paul-Elder Model provides the theoretical foundation for this approach, offering a detailed framework for defining the elements and characteristics of critical thinking, which in turn informs the development of learning objectives.

To develop critical thinking growth in writing instruction, the Goal Layer comprises seven specific behavioral objectives, formulated based on the Paul-Elder critical thinking framework and long-term observations of students' cognitive engagement in writing tasks. These objectives not only encapsulate key elements of critical thinking but also serve as behavioral representations of students' reasoning processes during writing. As such, they function as concrete instructional goals, guiding both learning activities and assessment criteria within the blended learning framework. This structured integration of cognitive development, instructional design, and technological support distinguishes the proposed model from conventional writing instruction, ensuring that students engage in writing as a critical thinking process rather than merely a language production task.

Table 1
Critical Thinking Target Behaviors in Writing Instruction

Critical Thinking Behaviors (as applied in writing instruction)	Object of Behaviors (Elements)	Traits of Behavior (Standards)
Identifying problems and goals in writing tasks	Problems, Goals	Clarity
Establishing key assumptions in writing	Assumptions	Significance
Differentiating information	Information	Relevance, Completeness
Defining concepts	Concepts	Accuracy, Depth
Making precise inferences and conclusions	Conclusions, Inferences	Accuracy, Logicality
Recognizing implicit descriptions	Implicit Information	Fairness, Breadth
Evaluating writing based on target criteria	All Elements	All Standards

The Core Learning Process Layer is divided into three stages: pre-class, in-class, and post-class, aligning with the process-genre approach to writing instruction. Each stage is designed to foster specific critical thinking skills through targeted learning activities. In the pre-class stage, instructional activities focus on introducing the background and situational context of different writing genres. This phase is designed to develop the critical thinking skills of identifying the problem and objectives of the writing task and establishing key assumptions of the writing genre. The in-class stage engages students in analyzing model texts, helping them develop differentiating information, clarifying concepts, and accurately summarizing conclusions and implications. The post-class stage emphasizes peer evaluation and self-assessment, cultivating students' ability to apply evaluation standards to writing and identify different perspectives in argumentation.

Integrating AI into the Learning Environment

The Learning Environment Layer supports the instructional activities at each stage by integrating both online and classroom learning environments, embodying the principles of blended learning. Effective blended learning design requires the appropriate use of

technology, including AI-powered tools, at the right time to enhance learners' skill development. This study's learning environment design is guided by this principle, ensuring that classroom learning and online learning complement each other to promote critical thinking development in writing instruction.

This blended learning model leverages the capabilities of AI to enhance various aspects of the learning environment. Specifically, AI tools are integrated to support in the following table (see table 2):

Table 2
Learning Environment integrated AI tools

Learning Phase	AI-Integrated Writing Activity	Description	Example Tools
Pre-Class (Online)	AI-Driven Content Curation	AI curates personalized articles, videos, and exercises based on students' proficiency levels and learning styles.	Adaptive AI platforms recommending readings based on prior engagement.
	Automated Genre Analysis	AI analyzes writing samples to identify key genre conventions such as thesis statements and organizational patterns.	Grammarly, ProWritingAid
	AI Chatbot for Initial Q&A	AI chatbot answers students' preliminary questions, promoting interactive learning.	ChatGPT, AI-powered FAQ chatbots
In-Class (Classroom)	Real-Time Feedback on Group Discussions	AI utilizes speech-to-text and sentiment analysis to provide real-time insights on argumentation and critical thinking in discussions.	AI transcription tools detecting reasoning patterns
	Personalized Learning Pathways	AI recommends additional resources and activities based on students' writing performance and interaction with AI tools.	Adaptive learning platforms adjusting writing task difficulty
	AI-Powered Writing Assistance	AI suggests sentence rephrasing, vocabulary improvements, and logical refinements to improve writing quality.	Quillbot, Wordtune
Post-Class (Online)	AI-Enhanced Peer Review	AI provides an initial layer of feedback on grammar and style, allowing students to focus on higher-order thinking during peer review.	Grammarly, ProWritingAid
	Automated Feedback on Elements of Thought	AI assesses writing based on Paul-Elder's critical thinking framework, evaluating aspects such as Purpose, Assumptions, Clarity, and Logic.	Custom AI tools analyzing critical thinking in writing

By strategically integrating these AI-powered tools, the blended learning model aims to create a more dynamic, personalized, and effective learning environment that fosters both critical thinking and writing proficiency. The use of AI tools are in consonance with the cultivation of critical thinking, supported by Park and Doo (2024), Zou et al. (2023), and Wu (2024). Each stage of the critical thinking-oriented blended learning model for English writing consists of specific instructional steps designed to both guide learning activities and foster critical thinking skills. These steps are structured into three phases: pre-class, in-class, and post-class.In the pre-class stage, instructors focus on preparing learning resources and designing tasks that help students develop genre awareness and audience sensitivity. Learning materials should provide background and situational context for different writing genres, enabling students to clearly define the objectives and challenges of the writing task. Teachers also formulate guiding questions and tasks to help students recognize the communicative goals of the genre and develop contextual assumptions. For instance, in job application writing, students must first understand that the goal is to secure an interview. They are then encouraged to consider the employer's perspective, anticipating what content would be most persuasive in a hiring context.

During the while-class stage, instructors implement four key instructional steps to deepen students' understanding of writing conventions and enhance their analytical thinking. First, they introduce fundamental concepts related to content, structure, language, and style, helping students develop a structured framework for analyzing model texts. Next, students engage in guided model text analysis, where they answer targeted questions about content organization, linguistic features, and stylistic choices. Through group discussions, they practice differentiating relevant information, summarizing key characteristics, and identifying the reasoning behind writing conventions. The instructor then facilitates a summary of genre-specific writing characteristics, addressing common challenges students face in synthesizing and analyzing information. Finally, students participate in practice exercises, such as comparing different genres to identify similarities and differences, reinforcing their ability to differentiate, classify, and synthesize information effectively.

The post-class stage emphasizes writing application and peer evaluation, ensuring that students refine their writing through critical assessment. First, students complete writing and evaluation tasks, allowing them to apply critical thinking skills in a comprehensive manner. Peer evaluation further encourages them to identify diverse perspectives in argumentation. To support effective assessment, students use evaluation rubrics, which provide clear criteria for analyzing and critiquing their peers' writing. The instructor models how to apply these rubrics, guiding students in their independent evaluation process. By integrating structured critique and revision, this phase ensures that students develop metacognitive awareness of their writing process, promoting deeper engagement with both their own work and their peers' perspectives.

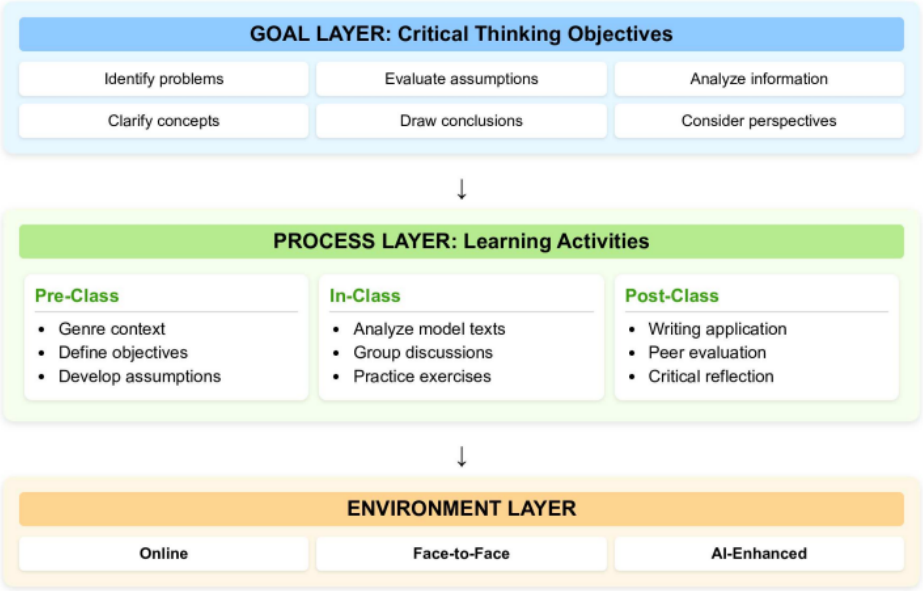

Figure 2. Critical-thinking Oriented Blended Learning Model

By systematically incorporating these instructional steps into pre-class, in-class, and post-class learning, this blended learning model (see Figure 2) effectively integrates writing skill development with critical thinking cultivation, ensuring that students engage in a process-driven, reflective approach to writing.

Implementing Conditions

While the critical thinking-oriented blended learning model provides a theoretical framework for fostering critical thinking skills, its successful implementation in practice requires a set of essential conditions. These conditions ensure that the model functions effectively and include factors such as learning environment, instructional resources, lesson planning, and teaching tools. For the Pre-Class Stage, the successful execution of the pre-class stage depends on several key conditions. First, the writing tasks and problem contexts should be authentic and realistic. A relatively real-world context allows students to clearly identify the objectives of the writing genre or task and establish a meaningful connection between the assigned task and the broader writing objectives. This also helps them form appropriate assumptions about the genre's conventions.

Then, collaborative group discussions should be incorporated to enhance students' understanding of writing objectives and situational context. Different students may approach the same writing task from varied perspectives, making group discussions a valuable tool for synthesizing diverse viewpoints and refining writing goals. At the same time, a combination of synchronous and asynchronous discussions is essential. Synchronous discussions enable real-time interaction, allowing students to engage in dynamic exchanges that help clarify writing objectives. Meanwhile, asynchronous discussions offer flexibility, giving students more time for in-depth reflection and a better opportunity to construct assumptions about the writing genre.

For the in-class stage, two critical conditions must be met. The first is the availability of an appropriate number of representative model texts. Since model texts serve as primary

learning materials, their selection significantly impacts students' ability to analyze and generalize genre-specific characteristics. The number of model texts should be sufficient to meet the learning objectives, and the texts chosen should be highly representative of the genre, ensuring that its distinctive features are clearly identifiable for students. The second condition is the provision of scaffolding through demonstration and guided instruction. Since the analytical tasks in this stage can be challenging, instructors need to facilitate learning by using questions, guided discussions, and structured summaries. These scaffolding techniques help students deepen their reasoning, refine their analytical skills, and complete their learning tasks effectively while strengthening their critical thinking abilities.

The post-class stage requires three primary conditions for effective learning outcomes. First, the use of scientifically designed and practical evaluation rubrics is essential. A well-structured rubric ensures that students can conduct in-depth and objective evaluations of their peers' writing. Additionally, the rubric should be user-friendly to minimize cognitive overload, allowing students to focus on the evaluation process itself rather than struggling with rubric complexity. Second, discussion of peer feedback should be encouraged. Students may not always agree with the feedback they receive, so interactive discussion forums provide an opportunity for them to further analyze, compare, and refine their perspectives. By engaging in these discussions, students develop a clearer understanding of their own and others' viewpoints, enhancing their critical evaluation skills.

Third, variation in peer review selection should be implemented. Each time students engage in peer review, they should evaluate different classmates' essays. This exposure to diverse writing styles and approaches enables students to analyze various writing techniques, gain insights from multiple perspectives, and receive feedback from different reviewers. This dynamic peer evaluation process broadens students' understanding of effective writing strategies while deepening their critical thinking and analytical abilities.

Role	Pre-Class Phase		While-Class Phase				Post-Class Phase		
The teacher	Prepare learning resources →	Set contextual tasks	Introduction and explanation →	Provide sample texts →	Raise key questions →	Summarize key points	Assign writing tasks →	Provide evaluation rubrics →	Demonstrate evaluation process
The students	Download learning resources →	Complete contextual tasks	Understand basic knowledge →	Read example texts →	Discuss questions →	Conduct related exercises	Complete writing tasks →	Conduct peer or self-evaluation →	Complete final draft

Figure 3. Implementation Phases and Roles of Blended Learning Model

By ensuring these implementation conditions across the pre-class, in-class, and post-class stages, the blended learning model (see Figure 3) can effectively integrate critical thinking development with writing instruction, providing students with a structured, interactive, and reflective learning experience.

Application and Effects

To evaluate the effectiveness of the AI-enhanced, critical thinking-oriented blended learning model, a quasi-experimental study was conducted integrating the existing AWE platform and readily available AI-powered tools to support specific learning activities, in a

college English writing course at a local technical and engineering university. The participants were undergraduate students from two naturally formed non-English major 2023 classes. It is important to acknowledge the inherent limitations of using naturally formed classes, as pre-existing differences between groups could potentially influence the results. This limitation is directly relevant to interpreting the findings related to RQ 1 and 2, where group comparisons are made. However, pre-test scores were used to assess baseline equivalence. Since some students were absent or failed to complete the required tasks during the course, their data were excluded from the final analysis, resulting in 26 valid participants in each class. Both classes were taught by the same instructor to ensure consistency.

To measure critical thinking skills and writing proficiency, the study adopted assessment criteria from the International Critical Thinking Test and the writing section of the TOEFL exam. The International Critical Thinking Test was chosen for its alignment with the Paul-Elder model, providing a framework for assessing both the elements of thought and the application of intellectual standards (Paul & Elder, 2006). The TOEFL writing section was selected for its established reliability and validity in assessing EFL writing proficiency (Educational Testing Service, 2023). This combination of assessments allowed for a comprehensive evaluation of both critical thinking and writing skills. All test data were analyzed using SPSS 24.0. Before the experiment, a pre-test was conducted to assess students' critical thinking abilities and writing proficiency, showing no significant difference between the two classes in these aspects. The two classes were then randomly assigned to an experimental group and a control group, and an 4-week teaching experiment was carried out. This duration, while relatively short, was chosen to provide a focused and intensive intervention within the constraints of an academic semester. This limited timeframe is a key consideration when interpreting the results, particularly in relation to RQ2, which examines writing proficiency. During the experiment, the experimental group received instruction based on the new blended learning model, while the control group followed a traditional teaching approach. After the experiment, a post-test was conducted to reassess critical thinking skills and writing proficiency, and the results of the pre-test and post-test were analyzed and discussed.

Impact on Students' Critical Thinking Skills

Table 3 presents the pre-test and post-test results for both the experimental group and the control group.The analysis revealed that both groups experienced a significant improvement in their critical thinking test scores (Experimental Group: $t = -4.346$, $p = .002$; Control Group: $t = -0.423$, $p = .034$). However, when comparing the post-test scores between the two groups, the experimental group demonstrated significantly higher scores than the control group ($t = 2.856$, $p = .005$). These findings suggest that the AI-enhanced blended learning model had a more positive impact on students' critical thinking development compared to the traditional teaching approach. This aligns with previous research demonstrating the positive effects of AI on critical thinking skills (Wu, 2024; Park & Doo, 2024). Specifically, the targeted integration of AI tools, such as automated feedback and personalized learning pathways, likely contributed to the enhanced critical thinking outcomes observed in the experimental group.

Table 3.
Pre-Test And Post-Test Results of International Critical Thinking Test

Test Phase	Group	Number of Students	Mean Score	Standard Deviation
Pre-test	EG	26	40.68	2.906
	CG	26	41.27	1.777
Post-test	EG	26	51.56	2.514
	CG	26	47.64	1.995

The **International Critical Thinking Test** consists of two sections: one assessing students' **ability to identify elements of thought**, and the other evaluating their **ability to measure these elements against intellectual standards**. The **experimental group** outperformed the **control group** significantly in both areas. A detailed analysis of students' test results revealed that, in terms of **element identification**, the **experimental group** showed the greatest improvement in their ability to **recognize assumptions, concepts, and inferences** (**see Table 4**). This suggests that the blended learning model effectively trained students to **identify key thinking elements** by guiding them through activities such as "**clarifying concepts", "establishing key assumptions about writing genres", and "accurately summarizing conclusions and implications".**

Table 4.
Improvement of Critical Thinking Elements in the Experimental Class

Item	**Pre-test (Mean)**	**Post-test (Mean)**	**Difference (Mean)**
Clarity	0.74	1.08	0.34
Accuracy	0.83	1.06	0.23
Relevance	0.84	1.05	0.21
Completeness	0.83	1.04	0.21
Significance	0.79	1.04	0.25
Depth	0.79	1.05	0.26
Breadth	0.71	1.02	0.31
Precision	0.73	0.99	0.26
Fairness	0.7	0.95	0.25
Logic	0.68	0.83	0.15

Regarding the application of intellectual standards, the greatest improvement in the experimental group's scores occurred in clarity, relevance, and breadth (see Table 4). Through structured learning objectives and AI-supported activities such as "identifying the problem and objectives of the writing task", "differentiating information", "recognizing multiple perspectives in argumentation", and "evaluating writing using standards", "supported by automated feedback and personalized recommendations", students developed a clearer understanding of these intellectual standards and successfully applied them to assess elements of thought. These findings provide specific evidence to support RQ1, demonstrating the positive impact of the model on distinct aspects of critical thinking.

Impact on Students' Writing Proficiency

Table 5 presents the **pre-test and post-test results** of writing proficiency for both the **experimental and control groups**. The analysis showed that both groups demonstrated a significant improvement in their writing scores (Experimental Group: t = -3.235, p = .003; Control Group: t = -3.169, p = .002). However, when comparing the post-test scores between the two groups, no significant difference was found (t = 1.012, p = .245). This result suggests that the AI-enhanced blended learning model and the traditional teaching model had similar effects on students' writing proficiency. Previous research has indicated a positive correlation between critical thinking and writing proficiency, meaning that higher critical thinking skills typically lead to better writing performance. However, in this study, although the experimental group showed greater improvement in critical thinking, their writing scores did not surpass those of the control group. Two main factors may explain this outcome.

Table 5
Writing Performance Statistics

Test Phase	Group	Number of Students	Mean Score	Standard Deviation
Pre-test	EG	26	65.22	1.46
	CG	26	63.58	1.11
Post-test	EG	26	71.04	1.874
	CG	26	68.02	1.65

On one hand, this writing course required students to write in English rather than their native language, making linguistic ability a critical determinant of writing performance. While the experimental group experienced a greater increase in critical thinking skills, their overall language proficiency may have been a limiting factor, preventing the full translation of their enhanced critical thinking into demonstrably improved writing scores. This highlights the complex interplay between critical thinking and language proficiency in EFL writing contexts. This finding, while not showing a statistically significant difference between groups, is important for understanding the multifaceted nature of writing development in EFL contexts. On the other hand, the observed improvements in critical thinking may not have fully translated into writing proficiency within the relatively short timeframe of the study. The development of writing skills is a complex process that involves multiple factors, including not only critical thinking but also linguistic knowledge, writing strategies, and practice (Hyland, 2003). While the AI-enhanced blended learning model provided targeted support for critical thinking, it's possible that a longer intervention period, or a more explicit focus on integrating critical thinking into the writing process itself, would be needed to observe a significant difference in writing proficiency.

Interaction Effect

In addressing RQ3, the analysis of interaction effect between the scores of CT and writing tests and the teaching modes provides further nuance to the findings. Although the main effects showed significant improvements in critical thinking for the experimental group, the absence of a significant interaction between the teaching mode (blended learning vs. traditional) and the pre-test scores on both critical thinking and writing suggests that the pre-

existing levels of these skills did not differentially influence the effectiveness of the intervention. In other words, the blended learning model was beneficial for students regardless of their initial critical thinking or writing abilities. This is a positive finding, indicating that the model is potentially adaptable to a range of learner profiles.

These findings highlight that while the **critical thinking-oriented blended learning model** significantly enhances **students' critical thinking skills**, its **impact on writing proficiency may take longer to manifest**, particularly in **foreign language writing contexts**.

Discussion and Conclusion

Discussion

This study's findings offer several key insights into the integration of AI to enhance critical thinking development in EFL writing instruction through a specifically designed blended learning model. The significant improvement in critical thinking scores in the experimental group, compared to the control group, underscores the potential of a structured, blended approach, supported by targeted AI applications, that explicitly targets critical thinking skills. The improvements in specific areas like identifying assumptions, concepts, and inferences, and in applying intellectual standards like clarity, relevance, and breadth, suggest that the model's concentric layered approach, combined with the process-genre writing pedagogy and the strategic use of AI tools, effectively scaffolds the development of these complex cognitive skills. This aligns with research demonstrating the effectiveness of AI in providing personalized feedback and adaptive learning pathways, which can contribute to improved critical thinking (Park & Doo, 2024; Zou et al., 2023; Wu, 2024). The AI tools, such as automated feedback on elements of thought and personalized recommendations, likely provided students with more focused and timely support, enabling them to engage more deeply with the critical thinking aspects of the writing tasks.

The lack of a statistically significant difference in writing proficiency between the two groups, despite the experimental group's gains in critical thinking, is a crucial point for discussion. As noted, this could be attributed to the relatively short duration of the intervention. Critical thinking skills, while demonstrably improved, may require a longer timeframe to translate into measurable improvements in EFL writing, where linguistic proficiency acts as a significant mediating factor.

It is also possible that the improvements in critical thinking were manifested in ways not fully captured by the TOEFL-based writing assessment. Future research could explore the use of more holistic and process-oriented writing assessments, such as portfolios or rubrics specifically designed to evaluate the integration of critical thinking into writing (e.g., assessing the quality of argumentation, the consideration of multiple perspectives, and the application of intellectual standards). This aligns with the call for more nuanced assessments of critical thinking in EFL writing contexts. Furthermore, exploring qualitative data, such as student reflections or think-aloud protocols during the writing process, could provide richer insights into how the AI-enhanced blended learning model impacted students' writing strategies and the interplay between critical thinking and writing performance.

Furthermore, the study's reliance on the Paul-Elder model, while providing a robust framework, may limit the scope of critical thinking considered. Exploring other models of critical thinking, such as those incorporating metacognitive and self-regulatory aspects (as

highlighted in Arthi & Gandhimathi, 2025) might offer additional insights. The cultural context (China) is also a relevant factor. As noted by both Lu and Xie (2024) and Wei and Li (2024), much of the research on ICT and AI and critical thinking in EFL/ESOL contexts is concentrated in specific regions. Replicating this study in diverse cultural settings and with different AI tools would be valuable. Future research should also explore the potential of other AI applications, such as natural language processing (NLP) tools for analyzing student writing and providing feedback on argumentation and reasoning (Park & Doo, 2024). The rapid advancements in AI, particularly in the area of generative AI, offer exciting possibilities for enhancing EFL writing instruction (Wu, 2024). Specifically, investigating the use of generative AI tools for providing more sophisticated and nuanced feedback on writing, beyond surface-level errors, could be a fruitful area for future research. However, ethical considerations and the potential for over-reliance on AI must be carefully addressed.

However, it's important to consider this finding in light of the non-significant difference in writing proficiency between the groups. It's possible that while the AI-enhanced blended learning model was effective in fostering critical thinking skills across the board, the transfer of these skills to writing performance requires more targeted support, longer exposure, or different types of writing tasks. Future research could explore the use of AI tools specifically designed to bridge the gap between critical thinking and writing, such as tools that provide feedback on argumentation structure, evidence use, and logical fallacies. Furthermore, investigating the qualitative differences in how students in the two groups approached the writing tasks (e.g., through think-aloud protocols or analysis of writing process data) could shed light on the mechanisms underlying the observed effects (or lack thereof). This study advances theoretical understanding by demonstrating that a theory-driven, AI-enhanced blended learning model can significantly improve critical thinking skills in EFL learners. It builds upon existing literature by providing empirical evidence for the effectiveness of a specific instructional design that combines the Paul-Elder model, the process-genre approach, and targeted AI integration. This contrasts with previous studies that have often focused on either blended learning in general or the use of specific AI tools without a clear theoretical framework for integrating critical thinking. The study's findings offer novel insights into the potential of AI to support not just language acquisition but also the development of higher-order thinking skills, which are crucial for success in the 21st century.

It's crucial to emphasize that the goal of integrating AI is not to replace the teacher but rather to augment their capabilities and provide students with more personalized and effective learning experiences. The teacher's role remains central in guiding students, providing feedback, and fostering a supportive learning environment.

Conclusion

This study developed and evaluated a critical thinking-oriented blended learning model for EFL writing instruction, integrating AI tools to enhance the learning environment and support the development of critical thinking skills. The findings demonstrate the model's effectiveness in significantly improving students' critical thinking skills. The structured, concentric three-layered approach, combined with the process-genre writing pedagogy and the strategic integration of AI-powered tools alongside online and offline learning environments, provides a practical framework for educators seeking to cultivate critical thinking in their students. While the immediate impact on writing proficiency was not

statistically significant, the substantial gains in critical thinking suggest a strong potential for long-term benefits. This is consistent with the broader literature on AI in education, which suggests that AI can be a powerful tool for personalizing learning, providing targeted feedback, and promoting deeper engagement (Park & Doo, 2024; Wu, 2024). However, the effective integration of AI requires careful consideration of pedagogical principles, the specific learning context, and the characteristics of the learners. This model serves as a valuable reference for incorporating critical thinking and AI into subject-specific instruction, particularly in EFL writing, and offers a foundation for designing goal-oriented blended learning models in various educational contexts.

The study contributes to the growing body of literature emphasizing the importance of explicit critical thinking instruction and the potential of blended learning, enhanced by AI, to facilitate this process. Future research should focus on exploring the long-term effects of this model, investigating its effectiveness in diverse contexts, examining the impact of different AI tools and integrations, and further elucidating the complex relationship between critical thinking development and EFL writing proficiency. Specifically, longitudinal studies that track students' progress over a longer period are needed to determine whether the observed improvements in critical thinking translate into sustained gains in writing performance. Furthermore, qualitative research methods, such as case studies and classroom observations, could provide richer insights into the student experience and the ways in which AI tools are used (and potentially misused) in the learning process.

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