Article

An Empirical Study on the Integration of Generative AI into Critical Reading and Writing Instruction in English Majors

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Abstract: Critical thinking-based reading and writing instruction in English majors serves as the core vehicle for developing students' higher-order foreign language cognition and critical pragmatic competence. Current teaching practices often suffer from issues such as superficial cognitive training, lack of personalized feedback, and limited dimensions of critical thinking development, making it inadequate for meeting the demands of cultivating innovative talents in the new era. This study employed a quasi-experimental design, focusing on second-year English majors at a university, and established an AI-enhanced teaching experimental group alongside a traditional classroom control group for a 16-week instructional period. Comprehensive analysis combining quantitative assessments and qualitative interviews demonstrated that generative artificial intelligence integrated deeply into classroom activities effectively fostered students' abilities in text deconstruction, logical reasoning, and critical reflection. Specifically, the experimental group showed statistically significant improvements in argumentative writing quality, analytical reading depth, and reflective thinking capacity compared to the control group. Qualitative interview data further revealed that students perceived the AI-enhanced environment as more engaging and supportive of autonomous critical inquiry. The findings validate the scaffolding role of generative AI in foreign language critical thinking education, providing empirical support and a practical framework for advancing reading and writing courses in English programs. This study contributes to the growing body of literature on technology-enhanced language pedagogy and offers actionable insights for curriculum designers and educators seeking to harness artificial intelligence for meaningful pedagogical improvement.

Keywords: generative AI; English majors; critical reading and writing; teaching empiricism; pedagogical innovation

Received: 01 June 2026
Revised: 16 July 2026
Accepted: 27 July 2026
Published: 31 July 2026

1. Introduction

Critical reading and writing, grounded in rigorous text interpretation, systematic logical analysis, and precise critical written expression, constitutes a foundational curriculum component for enhancing students' humanistic literacy and advanced pragmatic competence within English language majors. Under conventional pedagogical models, instruction in this domain has largely centered on discrete knowledge transmission—emphasizing lexical precision, syntactic parsing, and surface-level textual comprehension—while underemphasizing higher-order cognitive development such as evaluative judgment of textual values, coherent construction of evidence-based arguments, and nuanced comparative examination across divergent interpretive frameworks. This persistent reliance on unidirectional delivery methods has inadvertently reinforced passive reception patterns among learners, constraining opportunities for autonomous inquiry, dialectical reasoning, and sustained intellectual engagement with complex texts [1]. Furthermore, in large-enrollment courses, instructors face significant constraints in delivering differentiated support aligned with individual learners' conceptual gaps; feedback on written assignments and classroom discourse

frequently remains broad and non-specific rather than calibrated to distinct cognitive profiles. Generative artificial intelligence tools offer promising affordances for foreign language education—including real-time linguistic analysis, identification of logical inconsistencies, facilitation of multi-perspective reasoning, and adaptive, learner-centered revision suggestions—thereby helping to mitigate longstanding limitations in traditional critical reading pedagogy. While scholarly discourse has increasingly articulated theoretical rationales and conceptual blueprints for AI-integrated instruction, empirical investigations remain comparatively scarce—particularly those combining robust quantitative measurement with rich qualitative insights drawn from actual classroom implementation. To address this gap, the present study implements a rigorously designed experimental teaching initiative, systematically assessing the pedagogical impact of generative AI integration on critical reading outcomes, identifying operational barriers encountered during classroom deployment, and refining scalable, intelligence-enhanced instructional strategies specifically oriented toward the professional formation of English language specialists.

2. Research Design

2.1. Research Question

This study responds to persistent pedagogical challenges in cultivating advanced critical reading and writing competencies among English majors within contemporary higher education contexts [2, 3]. Grounded in the evolving landscape of digital pedagogy, the research centers on two interrelated, empirically grounded questions. First, does a generative AI-enhanced teaching model—characterized by adaptive feedback generation, interactive text analysis scaffolds, and personalized writing revision support—yield statistically significant and pedagogically meaningful improvements in students' holistic critical literacy development, as measured across multiple validated dimensions including textual interpretation accuracy, coherence and rigor of logical reasoning, depth and originality of critical reflection, and metacognitive awareness of rhetorical strategies? Second, through systematic classroom implementation and qualitative inquiry, what are the pedagogically salient advantages—such as enhanced student engagement, differentiated instruction capacity, and real-time formative assessment opportunities—as well as practical constraints—including technological accessibility, instructor training requirements, algorithmic bias mitigation, and alignment with curriculum standards—that shape the effective integration of generative AI tools into discipline-specific critical literacy instruction?

2.2. Study Subjects

This study employed a quasi-experimental design utilizing two parallel second-year English major classes from a local university, with a total of 86 undergraduate students evenly distributed across the two groups (43 students per group). Prior to the commencement of the instructional period, all participants completed a standardized baseline assessment designed to evaluate core professional competencies in critical reading and academic writing. Statistical analysis confirmed no significant intergroup differences in foundational literacy proficiency or initial critical thinking capacity ($p > 0.05$), thereby establishing equivalence at the outset [4]. To ensure methodological rigor and internal validity, multiple extraneous variables were systematically controlled: both groups were taught by instructors with comparable pedagogical experience and qualifications; followed identical syllabi aligned with national curriculum guidelines for English majors; received the same number of contact hours per week; used the same officially approved textbooks and supplementary materials; and were evaluated using uniformly calibrated rubrics and assessment protocols. The instructional period extended over the full duration of the spring semester—16 consecutive weeks—with consistent scheduling and delivery to support longitudinal skill development and reliable measurement of learning outcomes. All procedural decisions adhered strictly to ethical research standards for educational studies involving human participants.

2.3. Teaching Intervention Program

The control group followed the established pedagogical approach for critical reading and writing instruction commonly implemented in English major curricula across higher education institutions. Instruction was predominantly teacher-centered, emphasizing close textual analysis conducted in real time during class sessions [1, 5]. The instructional sequence prioritized structural organization of source materials, systematic identification and resolution of salient linguistic difficulties—including lexical ambiguity, syntactic complexity, and discourse-level cohesion—and explicit modeling of conventional reading and writing frameworks. Critical thinking development relied on standardized classroom activities such as instructor-initiated questioning protocols and fixed small-group discussion formats. These practices, while consistent and administratively efficient, yielded limited differentiation in cognitive engagement; the uniformity of task design and procedural rigidity constrained responsiveness to learners' varying levels of analytical maturity, epistemic awareness, and metacognitive regulation. Assessment of out-of-class assignments employed aggregated grading procedures, with feedback delivered in generalized form rather than individualized diagnostic commentary. Such feedback predominantly addressed surface-level linguistic accuracy—such as grammatical conformity, punctuation consistency, and syntactic clarity—while seldom engaging with foundational reasoning competencies: the coherence and validity of argumentative structures, the breadth and depth of perspective-taking, the sufficiency and representativeness of evidentiary support, or the capacity for reflective synthesis across multiple sources. As a result, opportunities for scaffolded progression toward advanced critical cognition—such as evaluative judgment, dialectical reasoning, and epistemic humility—remained underdeveloped due to the absence of deliberate, sequenced, and learner-responsive instructional strategies.

The experimental group implemented an AI-integrated pedagogical framework specifically designed to cultivate domain-specific critical thinking capacities through structured, stage-wise support. This framework operationalized large language models not as autonomous content generators but as adaptive cognitive partners aligned with evidence-informed instructional principles. In the pre-class preparation phase, students engaged with AI tools to perform contextual reconnaissance—mapping historical, cultural, and disciplinary backgrounds of assigned texts; extracting and reconstructing core claims and implicit assumptions; generating alternative interpretive hypotheses grounded in divergent theoretical lenses; identifying latent value conflicts embedded in rhetorical positioning; and formulating open-ended, conceptually rich questions that prompted deeper inquiry beyond literal comprehension. During in-class exploration, AI-supported interaction enabled dynamic deconstruction of textual reasoning architectures—segmenting arguments into premises, warrants, and conclusions; juxtaposing contrasting ideological or methodological stances; conducting real-time logical validity checks using formal and informal reasoning criteria; detecting and mitigating common cognitive distortions such as confirmation bias or false dilemma reasoning; and expanding analytical scope through multimodal data integration (e.g., linking textual claims to empirical datasets or visual representations). In the post-class consolidation phase, AI-generated evaluations extended beyond linguistic correctness to assess argumentative integrity—evaluating logical entailment, evidentiary alignment, conceptual originality, and rhetorical adaptability across audience and purpose. Diagnostic outputs precisely mapped individual learners' reasoning gaps—such as overreliance on anecdotal evidence, insufficient counterargument engagement, or weak causal inference—and generated personalized developmental pathways featuring calibrated practice tasks, annotated exemplars, and progressively scaffolded prompts. All technical functionalities were governed by strict pedagogical guardrails: AI output was never presented as authoritative truth, student authorship remained non-delegable, and all generative outputs required substantive human reinterpretation, justification, and revision—thereby preserving intellectual agency as the cornerstone of learning [6].

2.4. Research Tools and Data Processing

This study adopts a mixed-method research paradigm to achieve methodological triangulation, thereby enhancing the validity and depth of empirical findings. The quantitative component draws upon psychometrically validated instruments, including a widely used English Critical Thinking Scale and standardized reading and writing assessment materials, which collectively constitute a robust, multi-dimensional evaluation framework. This framework systematically assesses four interrelated competencies: text interpretation, logical reasoning, argumentation expression, and critical reflection. All assessments were administered under consistent procedural conditions both prior to and following the instructional treatment phase, ensuring temporal comparability and internal consistency. Qualitative data collection was conducted through three complementary sources: semi-structured interviews with participants to elicit nuanced perspectives on learning processes; systematic classroom observations employing an established observational protocol to document pedagogical interactions and discourse patterns; and in-depth analysis of authentic student writing samples to trace developmental trajectories in critical language use. Quantitative data underwent rigorous statistical analysis using SPSS 26.0, specifically paired-sample t-tests to evaluate within-group changes over time and independent-sample t-tests to compare outcomes across experimental and control conditions. Qualitative data were analyzed through iterative grounded theory procedures, beginning with open coding to identify emergent concepts, followed by axial coding to establish conceptual relationships and theoretical categories, ultimately yielding empirically grounded insights into instructional effectiveness and learner engagement.

3. Research Findings and Analysis

3.1. Analysis of Overall Performance Differences between Groups Before and After the Experiment

Pre-test data demonstrated no significant statistical differences in overall critical reading and writing scores—or in any of their sub-dimensional components—between the experimental and control groups ($p > 0.05$), confirming baseline equivalence in foundational academic competencies and satisfying essential methodological prerequisites for comparative educational research. Following a 16-week period of instruction incorporating differentiated pedagogical strategies supported by generative artificial intelligence tools, measurable developmental divergence became evident across multiple assessment domains. The control group exhibited minimal to no statistically meaningful change in any measured outcome, indicating that conventional lecture-centered instruction sustains basic language competence but does not reliably promote the growth of higher-order cognitive capacities such as analytical reasoning, evaluative judgment, or synthetic argumentation—key competencies required for advanced academic literacy. Conversely, the experimental group demonstrated substantial and statistically robust improvements in both composite post-test performance and all constituent dimensions—including textual analysis, logical inference, rhetorical evaluation, and evidence-based composition—with mean score gains significantly exceeding those of the control group ($p < 0.01$). These results suggest that thoughtfully designed integration of generative AI technologies into language instruction can meaningfully augment pedagogical effectiveness, particularly in fostering complex cognitive processes traditionally underdeveloped through standard curricular approaches [7]. Such outcomes reflect broader empirical trends observed in contemporary research on technology-mediated language learning, where adaptive, interactive, and feedback-rich digital environments consistently correlate with enhanced metacognitive awareness and disciplinary discourse proficiency.

3.2. Analysis of Differentiated Outcomes Across Various Critical Thinking Dimensions

Comparative analysis of segmented data reveals that students in the experimental group demonstrated the most significant improvement in critical reflection and logical

reasoning skills—two foundational dimensions of higher-order cognitive engagement. In traditional teaching environments, students have long relied on teachers' textual interpretations as authoritative sources, often resulting in homogenized perspectives, fragmented arguments, and insufficient dialectical thinking capacity; this pedagogical pattern constrains learners' ability to think independently beyond established cognitive frameworks and limits their capacity to interrogate assumptions, identify implicit biases, or evaluate competing claims systematically. Generative AI, leveraging vast multilingual textual corpora and advanced logical analysis capabilities, provides students with diverse interpretive perspectives grounded in cross-cultural, historical, and disciplinary contexts. It supports systematic identification of logical flaws—including hasty generalizations, false dichotomies, and causal oversimplifications—and delivers targeted dialectical training through iterative questioning, counterpoint generation, and epistemic stance analysis. This approach encourages students to actively question not only text content but also authorial positioning, rhetorical strategies, ideological underpinnings, and sociocultural contingencies embedded within discourse. At the textual interpretation level, AI assists students in uncovering implicit meanings, tracing underlying logical structures, recognizing value-laden terminology, and discerning unstated presuppositions—thereby helping learners avoid superficial reading pitfalls and cultivate hermeneutic depth. Regarding argumentation, its precise dimensional feedback enables students to optimize discourse structure by clarifying thesis statements, sequencing claims logically, strengthening evidence support systems through multimodal sourcing and credibility assessment, and rectifying logical inconsistencies such as non sequiturs or equivocation—significantly enhancing the rigor, coherence, and persuasive efficacy of their critical written expressions.

Meanwhile, empirical data indicate only modest improvement in students' language proficiency at the foundational level—specifically in areas such as grammatical accuracy, lexical range, and phonological awareness—further demonstrating that generative AI's core educational value lies in fostering higher-order thinking rather than reinforcing basic linguistic knowledge, a distinction consistent with the advanced pedagogical objectives of critical reading and writing courses [8]. This finding underscores a crucial conceptual boundary: while AI tools are not substitutes for structured language instruction, they serve as powerful cognitive scaffolds that extend traditional pedagogy into domains requiring metacognitive awareness, epistemic humility, and intellectual autonomy. The observed differential impact across skill domains suggests that AI-enhanced instruction does not replace traditional language teaching but precisely addresses its longstanding shortcomings in cultivating analytical depth, evaluative judgment, and reflective synthesis—capabilities increasingly emphasized in national curriculum standards for advanced literacy development. Moreover, longitudinal classroom observations confirm that sustained AI-mediated practice correlates with improved self-regulation in critical inquiry, greater tolerance for ambiguity in complex texts, and enhanced capacity to integrate multiple viewpoints into coherent, evidence-informed positions—outcomes that collectively reinforce the transformative potential of intelligent technologies when aligned with sound pedagogical principles and rigorous academic oversight.

3.3. Analysis of Qualitative Research Results

The qualitative research data further corroborates the findings of the quantitative study. Interview results revealed that a substantial majority—88.4%—of students in the experimental group perceived the integration of AI tools as instrumental in broadening their critical thinking perspectives. This perception aligns with observed improvements in addressing persistent pedagogical challenges commonly encountered in conventional English language instruction, including inflexible cognitive patterns, superficial engagement with complex textual material, and limited opportunities for metacognitive reflection [9]. In contrast to traditional teacher-led feedback—which, while comprehensive, is often delayed due to workload constraints—AI-supported systems deliver timely, adaptive, and multidimensional evaluation. Such systems dynamically

assess linguistic reasoning, argument structure, evidentiary coherence, and interpretive nuance, enabling precise identification of individual cognitive gaps and domain-specific weaknesses in critical analysis. Moreover, they generate scaffolded, actionable suggestions tailored to each learner's developmental trajectory. Classroom observation data consistently documented marked growth in student-initiated inquiry behaviors: learners demonstrated increased willingness to pose original questions, interrogate underlying assumptions in source materials, compare competing interpretations, and construct evidence-based arguments. Rather than defaulting to canonical readings or instructor-endorsed positions, students engaged in autonomous textual interpretation, applied contextual reasoning across genres, and sustained extended analytical dialogues—thereby strengthening both higher-order thinking competencies and foundational inquiry-based learning capacities.

This pedagogical approach also underscores important operational boundaries in deploying intelligent technologies for critical thinking development. A subset of learners exhibited emerging patterns of cognitive dependency, wherein repeated reliance on AI assistance for core intellectual tasks—including close reading, synthesis of divergent viewpoints, logical mapping of claims and counterclaims, and formulation of original evaluative judgments—correlated with diminished motivation for self-directed analysis and reduced persistence in grappling with ambiguity. Such tendencies risk reinforcing passive information consumption rather than cultivating intellectual agency. Additionally, current generative models face inherent constraints in handling culturally embedded discourse, particularly when interpreting literary works from non-Western traditions or analyzing ethically contested themes in global English-language texts. Limitations arise from training data imbalances, implicit cultural biases encoded in model architectures, and insufficient representation of pluralistic epistemologies in algorithmic logic. Consequently, AI-generated analyses may occasionally misrepresent historical context, overlook sociolinguistic nuance, or oversimplify morally complex dilemmas—shortcomings that compromise the depth, fairness, and humanistic integrity expected in English major curricula. Therefore, continuous human oversight remains indispensable: educators must actively monitor outputs, contextualize AI responses, supplement with culturally grounded examples, and facilitate reflective dialogue that foregrounds ethical reasoning, intercultural competence, and disciplinary rigor. This synergistic human–machine framework—not technological substitution—is central to sustainable, equitable, and academically robust critical thinking education.

4. Teaching Insights and Optimization Strategies

4.1. Building an AI-powered, Hierarchical Critical Thinking Education System

Individual variations in students' critical thinking competencies constitute a core dimension of English literacy education, requiring systematic pedagogical attention. Conventional one-size-fits-all instructional methods often prove insufficient in accommodating the heterogeneous cognitive development trajectories observed across learners—high-achieving students may experience under-stimulation and limited intellectual challenge, while those with emerging foundational skills may encounter persistent difficulties when engaging with advanced analytical tasks. Drawing upon accumulated classroom evidence and longitudinal teaching practice, educators can integrate intelligent educational technologies to construct a dynamic, AI-supported, hierarchical framework for critical reading and writing instruction. This framework replaces static, uniform delivery with adaptive, level-sensitive scaffolding grounded in empirically validated cognitive benchmarks. Proficiency stratification is conducted using objective, observable indicators—including depth of textual interpretation, structural coherence and evidentiary rigor in argumentation, and consistency of metacognitive engagement during analysis. At the foundational tier, instruction prioritizes disciplined close reading, identification of explicit and implicit claims, and application of elementary logical structures to build procedural fluency in analytical reasoning. The intermediate

tier advances learners toward integrative cognition: comparing competing interpretations, evaluating rhetorical strategies across genres, and constructing balanced, evidence-informed arguments that acknowledge complexity and ambiguity [3, 10]. The advanced tier engages students with interdisciplinary, cross-cultural texts—such as comparative literary criticism, global policy discourse, or scientific ethics debates—and emphasizes original synthesis, methodological self-reflection, and scholarly writing conventions. Continuous formative assessment, supported by real-time analytics from learning platforms, enables timely recalibration of task difficulty, feedback specificity, and conceptual emphasis—thereby sustaining optimal challenge and fostering sustained growth in higher-order thinking capacities across diverse learner profiles.

4.2. Adhere to the Principle of Dual Focus on Teacher Leadership and Student-Centeredness

The integration of intelligent technologies into foreign language classrooms has not altered the fundamental human-centered nature of education. Critical reading and writing instruction continues to serve as a vital, self-directed developmental process aimed at cultivating students' cultural literacy, analytical reasoning, and reflective judgment. This pedagogical objective necessitates a balanced instructional framework in which teachers provide structured guidance while simultaneously nurturing learners' capacity for independent intellectual engagement—understood here strictly as academically grounded self-regulation in learning tasks, rather than any socio-political connotation. Within intelligent learning environments, empirical observation indicates a growing tendency among learners to rely excessively on digital tools for text interpretation, idea generation, and logical structuring—potentially diminishing opportunities for sustained cognitive effort, metacognitive reflection, and original conceptual synthesis. This pattern was observed during the implementation of the teaching initiative under review. Consequently, educators are called upon to clarify and reinforce pedagogical roles: autonomous critical thinking and creative expression must remain non-negotiable learning outcomes, whereas intelligent tools function exclusively as supplementary resources—supporting knowledge consolidation, scaffolding conceptual clarification, and enriching analytical depth—not as substitutes for core intellectual labor. A deliberate sequencing strategy—'think-first, assist-later; create-first, refine-later'—is recommended: students should first engage directly with source texts, formulate interpretive claims, draft coherent arguments, and produce initial written work without technological mediation. Only afterward should tools be deployed to identify conceptual gaps, verify linguistic accuracy, broaden contextual understanding, or enhance rhetorical precision. Teachers, meanwhile, fulfill an irreplaceable human role by offering nuanced feedback on argument validity, evaluating ethical and aesthetic dimensions of student interpretations, facilitating Socratic dialogue, organizing structured debates, and conducting close textual case studies—all of which sustain rich, multidimensional interactions among learners, educators, and digital resources within a values-informed, cognitively rigorous learning ecosystem.

4.3. Improving the AI-based Critical Thinking Assessment Mechanism

Teaching evaluation constitutes a foundational pillar in advancing the quality, rigor, and pedagogical responsiveness of critical thinking literacy instruction. Conventional assessment paradigms—centered overwhelmingly on end-of-term summative examinations—offer only a static snapshot of final achievement, thereby overlooking the iterative, nonlinear, and context-sensitive nature of cognitive development in critical thinking [5]. Such models suffer from three interrelated deficiencies: first, an overreliance on decontextualized, isolated tasks that fail to mirror authentic intellectual engagement; second, a narrow focus on surface-level linguistic or structural features while neglecting deeper epistemic competencies such as epistemological awareness, metacognitive regulation, and ethical reasoning; and third, significant temporal delays between student performance and evaluative feedback, which undermines formative utility. To address these constraints, a reimagined evaluation architecture must be inherently process-oriented, multidimensional, and adaptive—integrating real-time analytics with reflective

human judgment. Intelligent assessment systems can systematically quantify objective textual features—including syntactic complexity, coherence markers, argumentative density, evidentiary grounding, and logical consistency—across iterative drafts and classroom interactions. Complementing this technical layer, educators must apply disciplined qualitative interpretation grounded in disciplinary standards and pedagogical wisdom, attending deliberately to students' capacity for perspective-taking, conceptual synthesis across domains, tolerance for ambiguity, and responsible deployment of critique in socially situated contexts. Furthermore, longitudinal tracking mechanisms—such as annotated portfolios documenting evolving analytical strategies, annotated peer feedback exchanges, instructor-led Socratic dialogue transcripts, and structured self-assessment rubrics—enable the construction of rich, individualized developmental narratives. This integrated framework not only enhances diagnostic precision but also empowers learners as active agents in their own cognitive maturation, reinforcing the principle that robust critical thinking is cultivated through sustained, scaffolded, and meaningfully assessed practice rather than episodic testing.

5. Conclusion

This study, grounded in a rigorously designed 16-week quasi-experimental instructional framework, provides robust empirical evidence that the deep, pedagogically intentional integration of generative AI tools into critical reading and writing curricula for English majors yields substantial gains in advanced cognitive competencies. Specifically, students demonstrated marked improvement in deep text interpretation—evidenced by nuanced engagement with intertextual layers, rhetorical strategies, and ideological subtexts—as well as strengthened logical reasoning capacities, including premise evaluation, argument reconstruction, and counterfactual analysis. Equally significant was the enhancement of critical reflection, manifested in metacognitive awareness of interpretive assumptions, ethical positioning in textual analysis, and self-directed revision practices. Classroom inquiry became more dynamic, collaborative, and student-centered, with AI serving not as a replacement for human judgment but as a scaffold for iterative sense-making. These outcomes directly address persistent challenges in traditional instruction: the underdevelopment of higher-order thinking skills and the systemic inefficiency of feedback delivery, particularly in large-enrollment or resource-constrained settings. Nevertheless, several constraints warrant careful attention: overreliance on AI-generated outputs risked diminishing students' independent analytical stamina, while mismatches between AI training paradigms and culturally situated literary traditions occasionally undermined interpretive depth and contextual fidelity. Moving forward, effective implementation must remain anchored in the core epistemological and humanistic aims of foreign language education—prioritizing linguistic agency, cultural literacy, and ethical discourse. This entails iterative refinement of AI use cases aligned with specific learning objectives, deliberate calibration of technical affordances against critical thinking dispositions, development of differentiated instructional pathways responsive to varied learner profiles, and design of multimodal, process-oriented assessment frameworks that value intellectual growth over output efficiency. Such an approach supports a sustainable, intelligent, and pedagogically grounded transformation of critical literacy instruction in English programs.

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