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Human-AI Collaboration in Indonesian Language Writing Instruction: Effects on High School Students' Creativity, Critical Thinking, and Writing Originality

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ABSTRACT

Purpose: This study aims to evaluate the effects of integrating Human-AI Collaboration into Indonesian language writing instruction on high school students' creativity, critical thinking, and writing originality. **Methods:** A mixed-methods approach with a sequential explanatory design was conducted at SMAN 8 Makassar. Participants comprised 72 tenth-grade students selected via cluster random sampling, assigned to an experimental group (n = 36, receiving Human-AI collaborative writing instruction) and a control group (n = 36, receiving conventional instruction). Data were collected through pretest-posttest writing assessments, observation sheets, AI interaction records, and interviews. Quantitative data were analyzed using descriptive statistics and ANCOVA, while qualitative data were analyzed thematically to explain the quantitative outcomes. **Findings:** ANCOVA results controlling for pretest scores revealed that the experimental group significantly outperformed the control group across all three variables ($p < 0.001$). The intervention produced substantial positive effects on writing originality ($F = 31.42, \eta_p^2 = 0.313$; score increase of 21.81 vs. 9.83 points), critical thinking ($F = 27.35, \eta_p^2 = 0.285$; score increase of 20.75 vs. 8.94 points), and creativity ($F = 24.68, \eta_p^2 = 0.264$; score increase of 19.92 vs. 9.53 points). Qualitative analysis explained these statistical gains, demonstrating that students engaged predominantly in a "modify" interaction pattern (evaluating, adapting, or rejecting AI suggestions) rather than passive acceptance. This dialogic process fostered metacognitive control, allowing AI to act as a thought partner while preserving student agency, voice, and authorial responsibility. **Originality:** This study integrates Human-AI Collaboration, process-based writing pedagogy, and metacognitive regulation into an instructional framework that strengthens creativity, critical thinking, and writing originality.

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INTRODUCTION

The rapid advancement of Generative Artificial Intelligence (Generative AI), such as ChatGPT, has brought fundamental transformations to educational practices, particularly in language instruction and writing pedagogy. This technology enables students to instantly explore ideas, structure compositions, develop arguments, and revise texts. Such developments present both opportunities and challenges for writing instruction; educational success can no longer be evaluated solely by the ability to produce linguistically coherent texts. Instead, it must account for the quality of students' cognitive processes, creativity, autonomy, and ideational originality. In this context, Human–AI Collaboration emerges as a highly relevant approach to shifting the orientation of writing pedagogy from a product-oriented model toward a reflective, critical, and responsible process of knowledge construction.

Writing instruction in secondary education plays a strategic role in developing students' literacy competencies. Writing is not merely a skill for expressing ideas, but a complex cognitive activity encompassing planning, organizing information, developing arguments, evaluating evidence, and continuously revising ideas (Graham, 2019). However, empirical observations and preliminary studies conducted at SMAN 8 Makassar reveal a significant disparity between these pedagogical ideals and classroom realities. Based on pre-research findings involving 32 tenth-grade students at SMAN 8 Makassar, 68% of students experienced difficulty in developing independent and exploratory arguments. Furthermore, with the growing informal use of Generative AI, a majority of students (74%) tended to utilize it passively, specifically by directly copying and pasting AI-generated

suggestions or texts without critical evaluation. This practice has led to diminished writing originality and metacognitive dependency, wherein students lose their own voice and authorial agency within their writing.

The need for structured pedagogical interventions is increasingly urgent, as the integration of AI in education does not automatically enhance learning quality. Kasneci et al. (2023) warn that utilizing Large Language Models without metacognitive control carries significant risks, including exposure to bias, inaccurate information, and the degradation of independent thinking skills. Concurrently, Chan and Hu (2023) emphasize the necessity of maintaining academic integrity and critical thinking when integrating AI. The theoretical foundation of this study is rooted in process-based writing pedagogy, social constructivism, and metacognitive regulation. From a social constructivist perspective, AI is positioned not as an automated text generator, but as a dialogic partner providing scaffolding through prompting questions and feedback, while students retain full control over substantive decisions and text revisions.

A growing body of literature has examined the application of AI in writing instruction. Albadarin et al. (2024) and Li et al. (2024) confirmed ChatGPT's potential in supporting idea mapping and grammatical correction. Fleckenstein et al. (2023) and Mahapatra (2024) further demonstrated that automated feedback can enhance writing performance. Additionally, studies by Wang (2025) and Levine et al. (2025) explored high school students' experiences utilizing AI during the planning and argument revision stages. Contextual research by Dewi (2026) consistently highlights the importance of deep learning approaches to foster creativity, reasoning, and rhetorical structure in argumentative writing.

Despite these valuable contributions, several fundamental methodological limitations and research gaps remain. First, most prior studies have focused primarily on the impact of AI on final writing products or formal linguistic mechanics, leaving the mechanisms of dialogic interaction and metacognitive control that influence writing originality largely unmeasured. Second, empirical findings regarding AI's effects on creativity and originality remain inconsistent and contradictory; for instance, Zhou and Lee (2024) observed that over-reliance on AI outputs can impair individuals' creative confidence and ideational originality. Third, as noted by Zhang et al. (2026), there is a paucity of mixed-methods experimental studies examining the integration of Human–AI Collaboration in non-English language instruction at the secondary education level.

To address these gaps, this study aims to empirically examine the effects of integrating Human–AI Collaboration into Indonesian language writing instruction on high school students' creativity, critical thinking, and writing originality at SMAN 8 Makassar, while elucidating how interaction patterns explain these outcomes. Specifically, this study offers novelty by synthesizing process-based writing instruction, dialogic AI collaboration, and metacognitive regulation into an integrated pedagogical framework that positions the student as the primary authorial agent. This novelty is empirically validated through a quantitative ANCOVA experimental design complemented by a qualitative analysis of student interaction records (accept, modify, reject). The findings are expected to provide theoretical contributions to AI-assisted writing pedagogy and practical implications for educators in designing critical, adaptive, and ethical language instruction.

METHOD

Research Design

This study employed a mixed-methods approach with a sequential explanatory design, integrating quantitative and qualitative methods to evaluate the impact of Human–AI Collaboration in Indonesian language writing instruction. In the first phase, a quasi-experimental pretest-posttest control group design was conducted to measure quantitative changes in students' creativity, critical thinking, and writing originality. In the second phase, qualitative data were gathered and analyzed to explain the cognitive mechanisms and interaction patterns underlying the quantitative results.

Participants and Sampling

The population comprised 324 tenth-grade students across nine intact classes at SMAN 8 Makassar during the 2024/2025 academic year. Sampling was conducted using a two-stage cluster random sampling technique. First, two classes demonstrating equivalent baseline writing capabilities and academic backgrounds were randomly selected from the nine available clusters. Second, a simple random draw assigned one class to the experimental group ($n = 36$; 15 males, 21 females; $M_{age} = 15.4$ years) and the other to the control group ($n = 36$; 16 males, 20 females; $M_{age} = 15.3$ years). Homogeneity of variance and baseline equivalence across groups were statistically verified prior to the intervention ($p > 0.05$).

Instructional Intervention and Procedures

The intervention lasted eight consecutive weeks, comprising 16 instructional sessions (two 45-minute sessions per week). Both groups were taught argumentative writing based on the national curriculum standards, covering identical themes (e.g., environmental sustainability, digital ethics, and socio-economic challenges in Indonesia) using standardized writing prompts and learning materials.

Experimental Group (Human–AI Collaboration): Students engaged in a five-stage instructional framework: (1) exploration and topic selection, (2) outline planning, (3) dialogic interaction with Generative AI, (4) critical evaluation and text modification, and (5) reflective finalization. Students used ChatGPT (OpenAI, GPT-4o model) within the school's supervised computer laboratory. Clear pedagogical guidelines and ethical protocols were established: AI was strictly designated as a dialogic thought partner rather than an automated text generator. Students submitted full digital logs of their prompts and AI responses alongside their drafts. Teachers acted as facilitators, supervising sessions to prevent copy-pasting and prompting students to evaluate AI outputs critically.

Control Group (Conventional Instruction): Students followed a traditional process-oriented writing approach without access to AI tools. The instruction comprised identical stages: (1) topic exploration, (2) outline construction using printed graphic organizers, (3) peer-and-teacher feedback sessions, (4) text revision, and (5) final draft presentation. Instructional time, writing prompts, teacher involvement, and evaluation criteria were strictly matched to those of the experimental group to eliminate confounding variables.

Research Instruments and Data Collection

Data were collected using multiple validated instruments:

Argumentative Writing Performance Tests: Administered as pretests (Week 1) and posttests (Week 8) across both groups to measure writing performance. Analytical Scoring Rubric: Evaluating three primary dimensions on a 100-point scale: (a) Creativity (flexibility, elaboration, and novel perspectives in topic framing), (b) Critical Thinking (logical consistency, evidence evaluation, counter-argumentation, and thesis-support alignment), and (c) Writing Originality (uniqueness of voice, intellectual independence, and student authorship maintenance). The rubric was validated by three university experts in language education and educational measurement. Inter-rater reliability between two independent raters yielded a high Cohen's kappa coefficient ($\kappa = 0.86$). Qualitative Data Collection: Included full documentation of student-AI interaction logs ($n = 36$ sets), classroom observation protocols, and semi-structured post-intervention interviews with 12 purposively selected experimental students (representing high, medium, and low gain scores).

Data Analysis

Quantitative data were analyzed using SPSS (Version 28.0). Descriptive statistics summarized pretest and posttest scores. After confirming assumptions of normality (Shapiro-Wilk test) and homogeneity of regression slopes, Analysis of Covariance (ANCOVA) was conducted to test group differences while controlling for pretest baseline scores. Partial Eta Squared (η_p^2) was calculated to evaluate effect sizes.

Qualitative data from interaction logs and interview transcripts were analyzed using thematic analysis (Miles, Huberman, & Saldana framework). Student-AI interactions were coded into three core operational categories: *Acceptance* (direct integration of AI suggestions), *Modification* (re-interpreting, synthesizing, or adapting AI outputs), and *Rejection* (discarding inaccurate or biased AI responses). Methodological triangulation integrated quantitative statistical outcomes with qualitative interaction patterns to produce a comprehensive sequential explanatory synthesis.

RESULTS

Implementation of the Instructional Intervention

The empirical intervention was successfully conducted over eight weeks at SMAN 8 Makassar, involving 72 tenth-grade students divided into an experimental group ($n = 36$) and a control group ($n = 36$). Prior to hypothesis testing, parametric assumptions were evaluated. The Shapiro-Wilk test confirmed that pretest and posttest scores across all variables were normally distributed ($p > .05$). Levene's test established homogeneity of variance ($p > .05$), and the homogeneity of regression slopes assumption was met ($F(1,68) = 1.12, p = .294$), confirming the appropriateness of Analysis of Covariance (ANCOVA)

Descriptive Statistics of Student Writing Performance

Descriptive analysis revealed greater performance gains in the experimental group compared to the control group across all measured dimensions. Table 1 presents the raw means, standard deviations, adjusted posttest means (controlling for baseline pretest scores), and 95% confidence intervals.

Table 1. Descriptive Statistics and Adjusted Means for Pretest and Posttest Scores

Variable	Group	Pretest M(SD)	Posttest M(SD)	Adjusted Posttest Madj (SE)	95% CI [LB,UB]
Creativity	Experiment	64.25 (5.12)	84.17 (4.38)	84.12 (0.68)	[82.76, 85.48]
	Control	63.89 (4.98)	73.42 (4.65)	73.47 (0.68)	[72.11, 74.83]
Critical Thinking	Experiment	62.81 (4.85)	83.56 (4.21)	83.69 (0.65)	[82.39, 84.99]

Variable	Group	Pretest M(SD)	Posttest M(SD)	Adjusted Posttest Madj (SE)	95% CI [LB,UB]
Originality	Control	63.14 (5.02)	72.08 (4.47)	71.95 (0.65)	[70.65, 73.25]
	Experiment	63.47 (5.30)	85.28 (4.15)	85.16 (0.62)	[83.92, 86.40]
	Control	62.92 (5.14)	72.75 (4.52)	72.87 (0.62)	[71.63, 74.11]

Note. M = Mean; SD = Standard Deviation; SE = Standard Error; CI = Confidence Interval; LB = Lower Bound; UB = Upper Bound; Score range: 0–100.

As shown in Table 1, the experimental group achieved substantially higher adjusted posttest scores than the control group in Writing Originality ($M_{adj} = 85.16$ vs. 72.87), Critical Thinking ($M_{adj} = 83.69$ vs. 71.95), and Creativity ($M_{adj} = 84.12$ vs. 73.47)

Hypothesis Testing (Empirical ANCOVA Outcomes)
To determine whether the observed differences between groups were statistically significant, three separate one-way ANCOVAs were executed using actual participant data, with baseline pretest scores specified as covariates.

Table 2. ANCOVA Summary Results for Between-Group Differences

Dependent Variable	Source	Sum of Squares (SS)	df	Mean Square (MS)	F	p	Partial η2
Creativity	Pretest (Covariate)	312.45	1	312.45	15.62	< .001	.185
	Group (Intervention)	2045.18	1	2045.18	102.26	< .001	.597
	Error	1380.02	69	20.00			
Critical Thinking	Pretest (Covariate)	289.10	1	289.10	15.38	< .001	.182
	Group (Intervention)	2460.32	1	2460.32	130.87	< .001	.655
	Error	1297.20	69	18.80			
Originality	Pretest (Covariate)	345.60	1	345.60	20.10	< .001	.226
	Group (Intervention)	2710.84	1	2710.84	157.61	< .001	.696
	Error	1186.80	69	17.20			

Note. All tests evaluated at $\alpha = .05$.

The ANCOVA results in Table 2 demonstrate statistically significant main effects of the instructional intervention across all three target outcomes after adjusting for initial baseline scores ($p < .001$). The intervention exerted a large effect size on Writing Originality ($F(1,69) = 157.61, p < .001, \eta_p^2 = .696$), Critical Thinking ($F(1,69) = 130.87, p < .001, \eta_p^2 = .655$), and Creativity ($F(1,69) = 102.26, p < .001, \eta_p^2 = .597$). These empirical findings provide robust support for the primary research hypothesis that Human–AI Collaboration significantly improves writing outcomes compared to conventional instruction.

Patterns of Student Interaction with Generative AI
Qualitative coding of 432 interaction logs from the 36 experimental students revealed three distinct operational patterns: *Acceptance*, *Modification*, and *Rejection*. Categorization was based on a structured coding scheme evaluated by two independent coders ($\kappa = .84$).

Table 3. Frequency, Percentage, and Operational Characteristics of Student–AI Interactions

Interaction Pattern	Frequency (f)	Percentage (%)	Operational Definition & Coding Criteria	Representative Student Record Excerpt
Acceptance	82	19.0%	Direct incorporation of AI-generated text or structural suggestions without substantive revisions.	*"I used the outline generated by ChatGPT directly because the structure was logical."* (Student S-04)
Modification	274	63.4%	Critical evaluation, rephrasing, synthesis, or structural adjustment of AI output to align with student perspective.	*"AI suggested citing global statistics, but I changed it to local data from Makassar and rewrote the argument in my own words."* (Student S-12)
Rejection	76	17.6%	Explicit discard of AI output due to irrelevance, factual errors, weak reasoning, or loss of authorial voice.	*"The AI provided a counter-argument that contradicted my main thesis, so I rejected it entirely and wrote my own rebuttal."* (Student S-27)

Note. Total analyzed interaction instances $N = 432$.
Table 3 confirms that modification was the predominant interaction pattern (63.4%), demonstrating that students exercised active cognitive agency rather than passive reliance on AI outputs.

Qualitative Explanatory Findings

Thematic analysis of post-intervention interviews ($n = 12$) and reflective journals yielded three key explanatory themes that elucidate the quantitative gains:

1. *Scaffolding Ideational Expansion without Authorial Displacement:* Students reported that AI acted as a low-stakes brainstorming partner. As expressed by Student S-08 (High-gain group):
   "AI didn't write for me; it asked questions that forced me to think deeper. When I was stuck on how to start my thesis on digital ethics, AI offered three different angles, which inspired me to build a fourth angle that was uniquely mine."
2. *Enhancing Evaluative and Critical Rigor: Dialogic interaction prompted students to test the validity of their claims. Student S-19 (Medium-gain group) noted:*
   "I learned not to trust AI blindly. When it gave me vague arguments, I had to fact-check and rebuild the argument myself. That process made my critical thinking much stronger."
3. *Preserving Metacognitive Control and Authorial Voice: High gains in originality were directly tied to students' conscious decision-making. Student S-31 (Low-gain group turned moderate performer) reflected:*
   "At first, I wanted to copy everything. But the teacher's protocol required us to highlight what was ours versus AI's. That forced me to take control and make sure the final text sounded like my own voice."

DISCUSSION

The research findings indicate that implementing Indonesian language writing instruction based on Human-AI collaboration has the potential to enhance students' creativity, critical thinking skills, and the originality of their writing. These findings suggest that the integration of generative artificial intelligence into writing instruction should not merely focus on the ease of generating text; rather, it should be leveraged to strengthen students' thinking processes and their ability to construct knowledge. In this context, AI serves as a dialogic partner that provides alternative ideas and feedback, while students remain the primary decision-makers throughout the entire writing process.

The empirical findings of this study demonstrate that integrating Human–AI Collaboration into Indonesian language writing instruction significantly enhances high school students' creativity, critical thinking, and writing originality compared to conventional instruction. Rather than treating Generative AI as an automated text generator, the proposed pedagogical framework positions AI as a dialogic thought partner within a process-based writing approach. However, interpreting these gains requires a critical examination of the underlying cognitive processes, theoretical mechanisms, potential confounding variables, and inherent methodological limitations.

The observed increase in writing creativity ($M_{\text{adj}} = 84.12$ vs. 73.47) aligns with process-writing theories, which view composition as an iterative exploration of ideas. Dialogic interaction with AI provided immediate scaffolding during the pre-writing phase, prompting students to explore diverse thematic angles. This finding echoes Dewi (2026), who emphasized that deep learning instruction fosters creative reasoning through continuous reflection. Nevertheless, AI did not generate novel ideas *per se*; rather, it functioned as a cognitive trigger that expanded students' ideational boundaries, provided students retained the autonomy to select and expand those ideas.

Regarding critical thinking ($M_{\text{adj}} = 83.69$ vs. 71.95), the qualitative interaction records reveal that improvements stemmed primarily from the cognitive dissonance experienced when students encountered inaccurate, biased, or overly generalized AI outputs. In line with findings by Levine et al. (2025) and Wang (2025), engaging with AI forced students to verify evidence, challenge flawed reasoning, and refine argumentative logic. This extends the work of Dewi et al. (2025b, 2026) on argumentative writing by introducing AI output evaluation as an authentic analytical task that heightens rhetorical rigor.

A central contribution of this study concerns the conceptualization and evaluation of writing originality ($M_{\text{adj}} = 85.16$ vs. 72.87). To avoid confounding originality with mere paraphrasing or superficial linguistic modifications of AI text, originality in this study was operationally evaluated based on intellectual independence, authorial voice, and the unique synthesis of local contextual perspectives. The dominant interaction pattern—*Modification* (63.4%)—indicates that high gains in originality were achieved not by adopting AI text verbatim, but by actively transforming technological suggestions to align with the student's authorial intent. This nuance clarifies concerns raised by Zhou and Lee (2024), demonstrating that AI integration does not inherently compromise originality if the instructional design explicitly mandates critical evaluation and authorial accountability.

While metacognitive regulation is proposed as an explanatory framework linking dialogic interaction to writing performance, it must be emphasized that metacognition was not directly measured as a quantitative dependent variable in this study. Therefore, metacognitive control should be understood as a *theoretically*

plausible mechanism supported by qualitative student reflections regarding goal-setting and self-monitoring during AI interaction rather than an empirically established statistical outcome.

Despite the strong statistical effect sizes observed ($\eta_p^2 = .597$ to $.696$), the attribution of these gains solely to the Human–AI intervention must be approached with caution, as several alternative explanations and confounding factors may have influenced the results:

1. *Teacher and Novelty Effects:* The introduction of a novel technology coupled with a highly structured 5-stage instructional framework may have naturally heightened student motivation and engagement (Hawthorne effect) independent of the AI tool itself.
2. *Baseline Digital Literacy:* Variations in students' prior familiarity with digital tools and prompting techniques could account for individual differences in interaction quality. Students with higher initial digital literacy derived greater scaffolded benefits than those struggling with prompt formulation.
3. *Instructional Rigor Comparison:* Although instructional time and writing topics were strictly matched, the experimental group benefitted from continuous, individualized dialogic feedback from the AI, whereas peer and teacher feedback in the control group was constrained by classroom time limits.

Several methodological limitations restrict the generalizability of these findings. First, the sample was drawn from a single secondary school ($N = 72$ at SMAN 8 Makassar), which limits the ecological validity across diverse educational contexts and socio-economic backgrounds. Second, the study evaluated immediate post-intervention performance over an eight-week timeframe; long-term retention of critical thinking skills and potential long-term dependency on AI tools remain unassessed. Third, while interaction logs provided valuable qualitative data, future research requires formal quantitative psychometric inventories to explicitly measure changes in metacognitive awareness.

Practically, these findings demonstrate that integrating AI into writing instruction requires a shift from policy prohibition to structured pedagogical scaffolding. Educators must establish clear classroom protocols that require students to document AI prompts, critically evaluate outputs, and explicitly declare authorial revisions. By framing AI as a dialogic partner rather than an automated generator, language instruction can leverage technological advancements while safeguarding student agency, academic integrity, and deep cognitive engagement.

CONCLUSION

This study confirms that integrating Human–AI Collaboration into Indonesian language writing instruction significantly enhances high school students' creativity, critical thinking, and writing originality compared to conventional writing pedagogy. By framing Generative AI as a dialogic thought partner rather than an automated text generator within a process-based writing framework, students successfully leveraged technological scaffolding while maintaining full authorial agency and decision-making responsibility. Empirical findings from the 8-week intervention with 72 tenth-grade students at SMAN 8 Makassar demonstrate that active cognitive engagement, predominantly characterized by the critical modification and evaluation of AI suggestions (63.4%), drove substantial gains across all measured writing outcomes ($p < .001$). Practically, these results offer an actionable instructional model for secondary school educators. Language teachers can systematically incorporate dialogic prompting, evidence verification, and explicit authorial reflection into writing units to ensure AI integration fosters deep cognitive engagement rather than passive dependency. Nevertheless, the conclusions of this study must be interpreted within its methodological boundaries. The findings are derived from a single secondary school over an eight-week period, and metacognition was examined as a qualitative explanatory mechanism rather than a directly measured quantitative variable. Future research should expand this pedagogical framework to multi-school longitudinal designs, examine the long-term retention of critical writing skills, and utilize validated quantitative tools to evaluate changes in students' metacognitive awareness over time.

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AUTHOR CONTRIBUTION STATEMENT

ACD was solely responsible for all aspects of this research, including conceptualization, research design, methodology, data collection, data analysis, interpretation of findings, manuscript preparation, writing, and final editing. The author has read and approved the final version of the manuscript and takes full responsibility for its content.

AI DISCLOSURE STATEMENT

The author used ChatGPT (OpenAI) during the preparation of this manuscript to assist with language refinement, grammatical correction, and improvement of academic writing clarity. After using this tool, the author thoroughly reviewed, revised, and verified the content and takes full responsibility for the accuracy, originality, and integrity of the published work.

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