



# The Impact of AI-Powered Writing Assistants on Efl Students' Writing Anxiety and Syntactic Complexity

Helga Ferdilla<sup>1\*</sup>, Metha Arisandi<sup>2</sup>

<sup>1-2</sup> Universitas Batam, Indonesia

\*Penulis Korespondensi: [helgaferdilla@univbatam.ac.id](mailto:helgaferdilla@univbatam.ac.id)

**Abstract.** *This quasi-experimental study investigated the impact of artificial intelligence-based writing assistants (Grammarly and QuillBot) on writing anxiety and syntactic complexity in Indonesian EFL students. Sixty-four undergraduate English Education students at a state university in East Java were divided into two groups: an experimental group (n = 32), which integrated an AI-based writing assistant into their essay writing process for 12 weeks, and a control group (n = 32), which received conventional writing instruction. Writing anxiety was measured using the Second Language Writing Anxiety Inventory (SLWAI) developed by Cheng (2004), while syntactic complexity was assessed through five indices using the L2 Syntactic Complexity Analyzer (L2SCA). Results of paired-samples t-tests and independent-samples t-tests indicated that the experimental group experienced a statistically significant reduction in writing anxiety ( $t = 4.83, p < 0.001, d = 0.87$ ), with the largest reduction in the cognitive anxiety subscale. Additionally, the experimental group showed significant improvements on four of the five measures of syntactic complexity: MLT ( $t = 3.27, p = 0.002$ ), C/T ( $t = 2.64, p = 0.011$ ), CN/T ( $t = 3.01, p = 0.004$ ), and MLC ( $t = 2.49, p = 0.016$ ). Interviews with 12 participants revealed that AI feedback helped create a sense of linguistic safety and encouraged experimentation with more complex syntactic structures. These results suggest that AI-based writing assistants are effective in reducing anxiety and increasing syntactic complexity in second language writing.*

**Keywords:** *AI-Powered Writing Assistants; EFL Writing; SLWAI; Syntactic Complexity; Writing Anxiety.*

## 1. INTRODUCTION

Writing is widely regarded as one of the most challenging productive skills for English as a Foreign Language (EFL) learners to master, particularly in academic contexts where linguistic precision and structural sophistication are expected (Hyland, 2019). In Indonesia, where English holds the status of a foreign language, university students majoring in English education frequently encounter significant difficulties in composing well-organized and grammatically complex academic essays (Cahyono et al., 2016). These difficulties are often compounded by affective variables, most notably writing anxiety, which has been consistently identified as a debilitating factor that negatively influences writing performance, learner motivation, and willingness to engage in writing tasks (Cheng, 2004; Wahyuni & Umam, 2017).

Writing anxiety in second and foreign language contexts is a multidimensional construct that encompasses cognitive, somatic, and behavioral dimensions. Cheng (2004) developed the Second Language Writing Anxiety Inventory (SLWAI), which operationalizes writing anxiety into three subscales: cognitive anxiety, characterized by negative expectations and worry about evaluation; somatic anxiety, involving physiological manifestations such as increased heart rate and tension; and avoidance behavior, reflecting the tendency to evade writing tasks. Numerous studies conducted in Indonesian EFL settings have confirmed that writing anxiety

is a pervasive phenomenon among university students, with cognitive anxiety consistently emerging as the most dominant subtype (Salikin et al., 2019; Sulfiana et al., 2021; Puspita, 2023). Kusumaningrum and Cahyono (2019) reported that Indonesian EFL students at Universitas Negeri Padang exhibited moderate levels of writing anxiety, with linguistic challenges and fear of negative feedback identified as primary contributing factors.

Concurrently, the construct of syntactic complexity has gained increasing scholarly attention as a critical indicator of L2 writing development and proficiency. Syntactic complexity refers to the range and sophistication of grammatical structures deployed in written production, typically measured through indices such as mean length of T-unit (MLT), clauses per T-unit (C/T), dependent clauses per clause (DC/C), complex nominals per T-unit (CN/T), and mean length of clause (MLC) (Lu, 2010, 2011; Ortega, 2003). Research has demonstrated that higher-proficiency L2 writers tend to produce longer production units, employ more subordination, and utilize more complex noun phrase structures than their lower-proficiency counterparts (Bulté & Housen, 2014; Jiang et al., 2019; Lei et al., 2023). However, the relationship between affective variables such as anxiety and the development of syntactic complexity in EFL writing remains underexplored.

The rapid advancement of artificial intelligence (AI) technology has introduced a new dimension to language education through the development of AI-powered writing assistants. Tools such as Grammarly, QuillBot, and ProWritingAid leverage natural language processing (NLP) and machine learning algorithms to provide automated feedback on grammar, vocabulary, sentence structure, and overall coherence (Fitria, 2023; Kim et al., 2023). Recent empirical studies have demonstrated that AI-assisted writing tools can significantly enhance EFL learners' writing skills across multiple dimensions. Song and Song (2023) found that ChatGPT-based writing instruction significantly improved Chinese EFL learners' academic writing skills while simultaneously reducing writing anxiety. Similarly, Ha (2023) reported that QuillBot-based interventions yielded significant improvements in Vietnamese university students' essay writing abilities, particularly in vocabulary, grammar, cohesion, and coherence.

Despite these promising findings, several critical research gaps persist. First, the majority of existing studies have focused primarily on the product-level impact of AI writing assistants on overall writing quality, with relatively limited attention to specific linguistic dimensions such as syntactic complexity (Wei et al., 2023). Second, while the anxiety-reducing potential of AI tools has been noted in several studies (Song & Song, 2023; Zhang et al., 2024), few investigations have systematically examined the relationship between AI-mediated feedback and changes in the specific subtypes of writing anxiety as conceptualized by Cheng (2004).

Third, the Indonesian EFL context, characterized by its unique sociolinguistic landscape and educational system, remains significantly underrepresented in the global literature on AI-assisted writing instruction.

To address these gaps, the present study investigates the following research questions: (1) To what extent do AI-powered writing assistants (Grammarly and QuillBot) reduce EFL students' writing anxiety as measured by the SLWAI? (2) What is the impact of AI-powered writing assistants on the syntactic complexity of EFL students' argumentative essays? (3) How do EFL students perceive the role of AI-powered writing assistants in their writing development?

## **2. LITERATURE REVIEW**

### **Writing Anxiety in EFL Contexts**

Writing anxiety, also referred to as writing apprehension, is a situation-specific form of anxiety that arises when individuals are confronted with writing tasks (Daly & Miller, 1975). In the domain of second and foreign language acquisition, writing anxiety has been recognized as a distinct construct that differs from general language anxiety and speaking anxiety (Cheng et al., 1999). Cheng's (2004) tripartite conceptualization of L2 writing anxiety—comprising cognitive anxiety, somatic anxiety, and avoidance behavior—has become the predominant theoretical framework guiding empirical research in this area. Cognitive anxiety, which involves worry, negative expectations, and preoccupation with evaluative outcomes, has been consistently reported as the most prevalent subtype among EFL learners across diverse educational contexts (Rezaei & Jafari, 2014; Wahyuni & Umam, 2017).

Within the Indonesian EFL context, writing anxiety has been extensively documented as a significant barrier to writing development. Salikin et al. (2019), investigating writing anxiety among Indonesian EFL students at Universitas Negeri Padang, found that the majority of participants exhibited moderate levels of writing anxiety, with cognitive anxiety as the most dominant subtype. Sulfiana et al. (2021) examined writing anxiety among Indonesian EFL students in post-pandemic online classrooms and reported that avoidance behavior emerged as the most common manifestation, experienced by 66.13% of participants. More recently, Ichwany and Cahyono (2025) explored writing anxiety among high school EFL learners in Malang, Indonesia, confirming moderate to high anxiety levels across both genders, with female students reporting slightly elevated anxiety scores. These findings collectively underscore the need for pedagogical interventions that can effectively address the multifaceted nature of writing anxiety in Indonesian EFL settings.

## **Syntactic Complexity in L2 Writing**

Syntactic complexity is a multidimensional construct that has been widely employed as an index of L2 writing quality and developmental progression (Bulté & Housen, 2012; Ortega, 2015). The construct encompasses several dimensions, including length of production units, degree of subordination, degree of coordination, and phrasal sophistication (Lu, 2010). The development of computational tools such as the L2 Syntactic Complexity Analyzer (L2SCA) by Lu (2010, 2011) and the Tool for the Automatic Assessment of Syntactic Sophistication and Complexity (TAASSC) by Kyle (2016) has significantly advanced the quantitative analysis of syntactic complexity in L2 writing research.

Research has consistently demonstrated that syntactic complexity measures are sensitive indicators of L2 writing proficiency. Jiang et al. (2019) investigated syntactic complexity across four proficiency levels using both large-grained and fine-grained measures, finding that higher-proficiency writers produced longer T-units, more subordinate clauses, and more complex noun phrases. Lei et al. (2023), in a large-scale longitudinal study of 1,081 Chinese university EFL students, reported that length-based measures and phrasal sophistication indices increased significantly over time, while clausal subordination measures decreased—a pattern indicative of increasing academic writing maturity. Bi and Jiang (2020) demonstrated that syntactic elaboration and diversity measures could collectively explain 45.3% of the variance in adolescent EFL learners' writing scores, with mean length of sentence, complex nominals per clause, and clauses per T-unit identified as the strongest predictors.

## **AI-Powered Writing Assistants in EFL Education**

The integration of AI-powered tools into language education has emerged as a transformative pedagogical approach in recent years. AI-powered writing assistants, such as Grammarly, QuillBot, and ProWritingAid, utilize sophisticated NLP algorithms to provide real-time, automated feedback on various aspects of writing, including grammatical accuracy, lexical appropriateness, sentence structure, and textual coherence (Fitria, 2023; Kim et al., 2023). These tools represent a significant evolution from earlier automated writing evaluation (AWE) systems by offering more context-sensitive, dialogic, and process-oriented feedback (Yan, 2024).

Empirical research on the effectiveness of AI writing assistants in EFL contexts has yielded predominantly positive results. Song and Song (2023) conducted a mixed-methods study evaluating the impact of ChatGPT-assisted language learning on Chinese EFL students' writing skills and motivation, finding that AI-assisted instruction created a less anxiety-inducing environment that facilitated improvements in academic writing proficiency. Wei et

al. (2023) reported that automated writing evaluation significantly improved Chinese EFL learners' writing skills in a randomized controlled trial. Yoandita and Hasnah (2024) demonstrated that QuillBot significantly enhanced Indonesian EFL students' academic writing performance over a 10-week intervention period. The iWrite AWE system was also found to improve university EFL students' writing performance across the complexity, accuracy, and fluency (CAF) framework while simultaneously reducing writing anxiety (Chen et al., 2026). Collectively, these studies suggest that AI-powered writing assistants hold considerable promise for addressing both cognitive and affective dimensions of L2 writing development.

### **3. METHOD**

#### **Research Design**

This study employed a quasi-experimental pretest-posttest control group design, supplemented by qualitative data obtained through semi-structured interviews. The mixed-methods approach was adopted to achieve both statistical generalizability and contextual depth in understanding the impact of AI-powered writing assistants on writing anxiety and syntactic complexity (Creswell & Creswell, 2018).

#### **Participants**

The participants were 64 undergraduate students (48 female, 16 male; age range: 19–22 years,  $M = 20.34$ ,  $SD = 0.87$ ) enrolled in the English Language Education program at a state university in East Java, Indonesia, during the academic year 2024/2025. All participants were in their fourth semester and were enrolled in the Academic Writing course. Two intact classes were randomly assigned as the experimental group ( $n = 32$ ) and the control group ( $n = 32$ ). An independent-samples t-test on the pretest SLWAI scores confirmed no statistically significant difference between the two groups at baseline ( $t(62) = 0.47$ ,  $p = .641$ ), ensuring initial equivalence. The participants' English proficiency ranged from B1 to B2 on the CEFR scale, as determined by a standardized placement test administered at the beginning of the semester.

#### **Instruments**

Three primary instruments were employed in this study. First, writing anxiety was measured using the Second Language Writing Anxiety Inventory (SLWAI) developed by Cheng (2004). The SLWAI consists of 22 items distributed across three subscales: Somatic Anxiety (7 items), Cognitive Anxiety (8 items), and Avoidance Behavior (7 items), rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument has demonstrated robust psychometric properties in previous studies, with Cronbach's alpha coefficients ranging from .82 to .88 for the three subscales (Cheng, 2004). In the present study,

the Cronbach's alpha for the overall scale was .89, with subscale reliabilities of .85 (Somatic Anxiety), .87 (Cognitive Anxiety), and .83 (Avoidance Behavior).

Second, syntactic complexity was assessed using the L2 Syntactic Complexity Analyzer (L2SCA) developed by Lu (2010, 2011). Five indices were selected based on their established validity as indicators of L2 writing development: mean length of T-unit (MLT), clauses per T-unit (C/T), dependent clauses per clause (DC/C), complex nominals per T-unit (CN/T), and mean length of clause (MLC). These indices represent the four major dimensions of syntactic complexity: length of production unit, degree of subordination, degree of coordination, and phrasal sophistication (Ortega, 2003; Lu, 2011).

Third, a semi-structured interview protocol comprising eight open-ended questions was developed to elicit participants' perceptions and experiences with AI-powered writing assistants. The protocol was validated by two experts in applied linguistics and was pilot-tested with five students not included in the main study. Interviews were conducted in both Indonesian and English to maximize participant expressiveness, and were audio-recorded with participants' consent.

### **Procedures**

The study was conducted over a 12-week period during one academic semester. In the first week, both groups completed the SLWAI pretest and wrote a timed argumentative essay (pretest essay) on the topic "Should universities require all students to take online courses?" (approximately 300–400 words, 60 minutes). During weeks 2–11, the experimental group engaged in weekly writing sessions that integrated Grammarly (for real-time grammar, vocabulary, and style feedback) and QuillBot (for paraphrasing, sentence restructuring, and vocabulary enhancement). Each session followed a structured protocol: (a) drafting an argumentative essay, (b) reviewing and reflecting on AI-generated feedback, (c) revising the draft based on the AI suggestions, and (d) submitting the final version. The control group followed the same writing schedule and essay topics but received conventional teacher-mediated feedback through written annotations and in-class peer review sessions. In week 12, both groups completed the SLWAI posttest and wrote a timed argumentative essay (posttest essay) on the topic "Should artificial intelligence replace human teachers in the classroom?" Both topics were validated by a panel of three EFL experts for equivalence in terms of cognitive demand and argumentative potential.

### **Data Analysis**

Quantitative data were analyzed using SPSS version 28. Descriptive statistics (means, standard deviations) were calculated for all variables. Paired-samples t-tests were employed to

examine within-group changes from pretest to posttest, while independent-samples t-tests were used to compare between-group differences on posttest measures. Effect sizes were calculated using Cohen's *d*. The assumption of normality was verified using the Shapiro-Wilk test, and Levene's test confirmed homogeneity of variances. For the syntactic complexity analysis, all 128 essays (64 pretest + 64 posttest) were processed through the L2SCA to generate the five target indices. Qualitative data from the semi-structured interviews were analyzed using thematic analysis following the six-phase framework proposed by Braun and Clarke (2006).

#### 4. FINDINGS AND DISCUSSION

##### The Impact of AI-Powered Writing Assistants on Writing Anxiety

Table 1 presents the descriptive statistics for the SLWAI scores across both groups at pretest and posttest.

**Table 1.** Descriptive Statistics of SLWAI Scores.

Variable	Experimental (n = 32)		Control (n = 32)	
	<i>Pre M(SD)</i>	<i>Post M(SD)</i>	<i>Pre M(SD)</i>	<i>Post M(SD)</i>
Overall SLWAI	72.41 (8.23)	58.94 (7.61)	71.88 (8.57)	69.53 (8.12)
Cognitive Anxiety	28.16 (4.12)	21.44 (3.89)	27.94 (4.34)	26.78 (4.15)
Somatic Anxiety	22.47 (3.56)	19.13 (3.22)	22.19 (3.71)	21.56 (3.48)
Avoidance Behavior	21.78 (3.45)	18.38 (3.07)	21.75 (3.62)	21.19 (3.41)

The paired-samples t-test revealed that the experimental group experienced a statistically significant reduction in overall writing anxiety from pretest ( $M = 72.41$ ,  $SD = 8.23$ ) to posttest ( $M = 58.94$ ,  $SD = 7.61$ ),  $t(31) = 4.83$ ,  $p < .001$ ,  $d = 0.87$ . The largest effect was observed in the cognitive anxiety subscale (pretest  $M = 28.16$ , posttest  $M = 21.44$ ),  $t(31) = 5.12$ ,  $p < .001$ ,  $d = 0.93$ , followed by avoidance behavior ( $t(31) = 3.76$ ,  $p = .001$ ,  $d = 0.68$ ) and somatic anxiety ( $t(31) = 3.21$ ,  $p = .003$ ,  $d = 0.58$ ). In contrast, the control group showed no statistically significant reduction in overall writing anxiety ( $t(31) = 1.24$ ,  $p = .224$ ) or any of the three subscales. The independent-samples t-test comparing posttest scores between the two groups confirmed that the experimental group scored significantly lower on overall SLWAI ( $t(62) = 5.31$ ,  $p < .001$ ,  $d = 1.34$ ), cognitive anxiety ( $t(62) = 5.22$ ,  $p < .001$ ,  $d = 1.31$ ), somatic anxiety ( $t(62) = 2.87$ ,  $p = .006$ ,  $d = 0.72$ ), and avoidance behavior ( $t(62) = 3.43$ ,  $p = .001$ ,  $d = 0.86$ ).

These findings are consistent with previous research demonstrating the anxiety-reducing potential of AI-assisted writing instruction. Song and Song (2023) reported that AI-assisted language learning created a less anxiety-inducing context that facilitated writing development, and the current findings extend this observation by demonstrating that the reduction in anxiety operates most strongly on the cognitive dimension. This is theoretically meaningful, as cognitive anxiety—encompassing worry about evaluation, negative expectations, and performance apprehension—is precisely the subtype most likely to be mitigated by non-judgmental, instant, and private AI-generated feedback. Unlike human evaluators, AI writing assistants provide corrective suggestions without social evaluation threats, thereby reducing the cognitive load associated with fear of negative judgment (Pekrun, 2006). This interpretation aligns with Control-Value Theory, which posits that learners' emotional responses to writing tasks are closely linked to their perceived control over the writing process, and that structured, supportive feedback systems can enhance learners' sense of control and reduce evaluative anxiety (Deane, 2018).

### The Impact of AI-Powered Writing Assistants on Syntactic Complexity

Table 2 presents the descriptive statistics and inferential results for the five syntactic complexity indices.

**Table 2.** Syntactic Complexity Indices: Pretest and Posttest Comparison.

Index	Exp Pre M(SD)	Exp Post M(SD)	Ctrl Pre M(SD)	Ctrl Post M(SD)	<i>t</i>	<i>p</i>	<i>d</i>
MLT	11.24 (2.13)	13.87 (2.41)	11.18 (2.08)	11.92 (2.19)	3.27	.002*	0.82
C/T	1.38 (0.21)	1.58 (0.24)	1.36 (0.22)	1.41 (0.23)	2.64	.011*	0.66
DC/C	0.31 (0.08)	0.35 (0.09)	0.30 (0.07)	0.32 (0.08)	1.87	.066	0.47
CN/T	1.12 (0.34)	1.47 (0.38)	1.10 (0.32)	1.18 (0.35)	3.01	.004*	0.76
MLC	8.14 (1.42)	9.36 (1.58)	8.09 (1.38)	8.47 (1.44)	2.49	.016*	0.63

Note. \*  $p < .05$ . The *t* and *p* values represent independent-samples *t*-tests comparing posttest gains between groups. Exp = Experimental; Ctrl = Control.

The results indicate that the experimental group demonstrated significantly greater gains in four of the five syntactic complexity indices compared to the control group. The most substantial improvement was observed in mean length of T-unit (MLT), which increased from 11.24 to 13.87 words in the experimental group, representing a gain of 2.63 words per T-unit compared to 0.74 in the control group. This difference was statistically significant with a large effect size ( $t(62) = 3.27, p = .002, d = 0.82$ ). Significant between-group differences were also

found for complex nominals per T-unit (CN/T), which increased from 1.12 to 1.47 in the experimental group ( $t(62) = 3.01, p = .004, d = 0.76$ ), clauses per T-unit (C/T), which rose from 1.38 to 1.58 ( $t(62) = 2.64, p = .011, d = 0.66$ ), and mean length of clause (MLC), which improved from 8.14 to 9.36 ( $t(62) = 2.49, p = .016, d = 0.63$ ). The only measure that did not reach statistical significance was dependent clauses per clause (DC/C), although a trend toward improvement was observed ( $t(62) = 1.87, p = .066, d = 0.47$ ).

These findings make a meaningful contribution to the literature on syntactic complexity development in L2 writing. The significant improvements in MLT, C/T, and MLC suggest that AI-powered writing assistants facilitated the production of longer and more structurally elaborate T-units and clauses, indicating enhanced sentential and clausal complexity. The significant gain in CN/T is particularly noteworthy, as research has established that complex nominals—including noun phrases with modifiers, appositives, and relative clauses—are characteristic of advanced academic writing and represent a shift from clausal to phrasal complexity that typifies L2 writing maturation (Biber et al., 2011; Bulté & Housen, 2014). The non-significant result for DC/C is consistent with Lei et al.'s (2023) longitudinal finding that clausal subordination tends to decrease as writers develop more sophisticated phrasal structures, suggesting that the experimental group may have been transitioning toward a more academically mature writing style.

The mechanism through which AI writing assistants appear to promote syntactic complexity gains can be understood through the lens of noticing and scaffolding. Grammarly's style suggestions frequently recommend sentence restructuring—such as converting simple sentences into complex sentences, adding modifying phrases, and reducing wordiness through nominalization—which effectively draws learners' attention to syntactic alternatives they may not have considered independently (Schmidt, 2001). QuillBot's paraphrasing function, similarly, exposes learners to diverse syntactic patterns for expressing the same semantic content, thereby expanding their syntactic repertoire. This interpretation is supported by the qualitative findings discussed in the following section.

### **Students' Perceptions of AI-Powered Writing Assistants**

Thematic analysis of the semi-structured interviews with 12 participants from the experimental group yielded three salient themes: (a) AI as a non-threatening feedback provider, (b) AI as a catalyst for syntactic experimentation, and (c) AI as a scaffold for autonomous learning.

Regarding the first theme, participants consistently reported that the non-evaluative nature of AI feedback significantly reduced their apprehension about making errors. One

participant (P3) stated: "When Grammarly shows me my mistakes, I don't feel embarrassed like when my teacher corrects me in front of the class. I can fix it privately and learn from it." Another participant (P7) noted: "I used to avoid writing long sentences because I was afraid of making grammar mistakes. But with QuillBot, I can try different structures and see which one works better without anyone judging me." These responses illustrate how the private, judgment-free nature of AI feedback alleviated cognitive anxiety and encouraged risk-taking in writing.

The second theme revealed that participants actively used AI tools to explore more complex syntactic structures. Participant P5 explained: "QuillBot showed me different ways to express my ideas. Sometimes it changed my simple sentence into a longer one with more details, and I learned new grammar patterns from that." Participant P11 similarly observed: "Grammarly sometimes suggested combining two short sentences into one with a relative clause or a participial phrase. After seeing many examples like this, I started doing it naturally." These comments suggest that AI tools functioned as implicit grammar instruction tools, promoting noticing and acquisition of more sophisticated syntactic forms.

The third theme highlighted the role of AI tools in fostering learner autonomy. Participants reported that the immediate and iterative nature of AI feedback enabled them to develop self-monitoring strategies and metalinguistic awareness. Participant P2 reflected: "Now I can see patterns in my writing mistakes. Grammarly always corrects my articles and prepositions, so I try to be more careful with those even before checking." This finding aligns with Ranalli's (2021) observation that automated feedback, when engaged with reflectively, can promote self-regulated learning practices and support the development of strategic writing competence.

## **5. CONCLUSION**

This study has provided empirical evidence that AI-powered writing assistants (Grammarly and QuillBot) can serve as effective pedagogical tools for simultaneously reducing writing anxiety and enhancing syntactic complexity among Indonesian EFL students. The experimental group demonstrated statistically significant reductions in overall writing anxiety and all three SLWAI subscales, with the most pronounced effect on cognitive anxiety. Concurrently, significant improvements were observed in four of five syntactic complexity measures (MLT, C/T, CN/T, and MLC), indicating that AI-assisted writing instruction facilitated the production of longer, more structurally elaborate, and more phrasally complex academic prose. Qualitative findings further corroborated these results, revealing that AI tools

functioned as non-threatening feedback providers, catalysts for syntactic experimentation, and scaffolds for autonomous learning.

These findings carry several important implications. Pedagogically, the results suggest that Indonesian EFL writing instruction can benefit substantially from the systematic integration of AI-powered writing assistants as supplementary tools that complement, rather than replace, human instruction. Instructors should consider incorporating structured AI-mediated writing protocols that guide students in critically engaging with AI-generated feedback rather than passively accepting suggestions. Theoretically, the study contributes to the growing body of evidence linking AI-assisted instruction to improvements in both affective and linguistic dimensions of L2 writing, thereby extending the applicability of Control-Value Theory and the noticing hypothesis to technology-enhanced writing pedagogy.

Several limitations should be acknowledged. First, the relatively small sample size ( $n = 64$ ) limits the generalizability of the findings. Second, the 12-week intervention period, while sufficient for detecting significant effects, may not capture the long-term trajectory of syntactic complexity development. Third, the study focused on argumentative essays, and the findings may not generalize to other writing genres. Fourth, the use of only two AI tools (Grammarly and QuillBot) constrains the generalizability to other AI writing assistants. Future research should employ larger samples, longitudinal designs, multiple writing genres, and a wider range of AI tools to provide a more comprehensive understanding of the role of AI-powered writing assistants in EFL writing development.

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