

## Fostering Arabic Writing Proficiency through an AI-Driven Spiral Learning Model

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### **Abstract:**

Writing proficiency in Arabic is one of the most challenging skills to acquire, particularly for learners without a strong linguistic background. Existing digital and AI-based approaches often address isolated aspects of writing—such as grammar or fluency—but rarely produce holistic improvements in morphology, syntax, vocabulary, and discourse organization. This study introduces and validates an AI-driven Spiral Learning Model, a recursive cycle of generate–evaluate–revise–reflect that integrates ChatGPT, Sarf.One, and ar-Radif with human intervention. Using a research and development design, the model was validated by experts and tested with 64 undergraduates of Arabic writing. Results showed significant improvements across linguistic and discourse features, while student reflections revealed increased critical awareness and autonomy in engaging with AI outputs. The findings contribute theoretically by extending spiral curriculum concepts into AI-assisted pedagogy and practically by offering a replicable strategy for higher education Arabic writing instruction.

**Keywords:** Arabic Writing; Spiral Learning Model; Artificial Intelligence; Recursive Pedagogy.

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## **Penguatan Kemahiran Menulis Bahasa Arab melalui Model Pembelajaran Spiral Berbasis Kecerdasan Buatan**

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### **Abstrak:**

Kemahiran menulis dalam bahasa Arab merupakan salah satu keterampilan yang paling menantang untuk dikuasai, khususnya bagi pembelajar yang tidak memiliki latar belakang linguistik yang kuat. Pendekatan digital dan berbasis kecerdasan buatan yang telah ada umumnya hanya menargetkan aspek-aspek menulis secara terpisah—seperti tata bahasa atau kefasihan—namun jarang menghasilkan peningkatan yang bersifat holistik pada aspek morfologi, sintaksis, kosakata, dan organisasi wacana. Penelitian ini memperkenalkan dan memvalidasi Model Pembelajaran Spiral Berbasis Kecerdasan Buatan, yaitu suatu siklus rekursif generate-evaluate-revise-reflect yang mengintegrasikan ChatGPT, Sarf.One, dan ar-Radif dengan intervensi manusia. Menggunakan desain penelitian dan pengembangan (research and development), model ini divalidasi oleh para ahli dan diujicobakan kepada 64 mahasiswa pada mata kuliah menulis bahasa Arab. Hasil penelitian menunjukkan peningkatan yang signifikan pada berbagai aspek linguistik dan wacana, sementara refleksi mahasiswa mengungkapkan meningkatnya kesadaran kritis dan kemandirian dalam berinteraksi dengan keluaran kecerdasan buatan. Temuan ini memberikan kontribusi teoretis dengan memperluas konsep kurikulum spiral ke dalam pedagogi berbantuan AI, serta kontribusi praktis melalui penyediaan strategi yang replikatif untuk pembelajaran menulis bahasa Arab di pendidikan tinggi.

**Kata Kunci:** Menulis Bahasa Arab; Model Pembelajaran Spiral; Kecerdasan Buatan; Pedagogi Rekursif.

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## INTRODUCTION

The mastery of Arabic writing (*mahārah al-kitābah*) remains one of the most demanding skills in foreign language education. Unlike receptive skills, writing requires learners to integrate morphological accuracy, syntactic coherence, semantic appropriateness, and stylistic awareness simultaneously (Afril et al., 2024; Han & Hiver, 2018). For students without a strong background in Arabic, the challenge becomes even more evident, as they struggle to transform grammatical knowledge into cohesive and contextually relevant texts (Dhanapal & Agab, 2023). This complexity places Arabic writing at the peak of linguistic proficiency, requiring not only linguistic competence but also reflective and critical thinking abilities (Weigle, 2011, p. 201).

Research on second language acquisition has long emphasized that writing is not merely a product but a process that involves planning, generating, revising, and reflecting (Hyland, 2019, p. 172). However, the process writing approach as commonly practiced is often implemented in a linear sequence, limiting students' opportunity to revisit and refine their texts cyclically (Tardy & Ferris, 2016, p. 143). While such models provide structure, they rarely accommodate the recursive and reflective nature of actual writing practices (Knoch et al., 2020).

The integration of digital platforms has expanded opportunities for writing pedagogy. Studies have shown that online tools increase learner autonomy, access to resources, and interaction in writing tasks (Alharbi, 2023; Asya et al., 2022). For Arabic, digital applications such as *I Read Arabic* or LMS-based resources have demonstrated some effectiveness in enhancing literacy skills (Ahsanuddin & Ma'sum, 2021). Yet, these approaches are frequently criticized for focusing on delivery efficiency rather than pedagogical depth (Ali, 2024). In many cases, digital tools have been used as supplementary aids, not as frameworks for rethinking the pedagogy of Arabic writing.

More recently, the rise of Artificial Intelligence (AI), particularly generative AI such as ChatGPT, has transformed the landscape of language education (Lo, 2023; Wang et al., 2023). AI can generate instant drafts, provide immediate feedback, and scaffold learners' attempts at writing (Dwivedi et al., 2023). However, its limitations are equally well-documented: inaccuracies in morphology, errors in syntactic agreement, inappropriate lexical choices, and cultural mistranslations (Kasneci et al., 2023; Matsiola et al., 2024). This indicates that while AI provides unprecedented support, it cannot function as an autonomous writing teacher without human intervention.

A number of studies in AI-assisted language learning confirm the potential of AI in augmenting learning outcomes. For example, Zou et al. (2023) showed that AI-supported writing activities improved learner confidence and fluency. Similarly, Lo (2023) highlighted that AI-driven scaffolding encouraged self-regulation in L2 writing tasks. Nevertheless, the majority of these studies have focused on English or other widely taught languages, leaving Arabic largely underexplored in AI-based pedagogical research (Alshammari & Elleithy, 2024).

Within Arabic pedagogy, several attempts to integrate technology have been reported. Research using social media platforms such as Instagram (Audina & Muassomah, 2020; Qori'ah et al., 2023) or WhatsApp (Sa'diyah, 2021) found that while these tools increase engagement, they do not constitute systematic



instructional models. Web-based tools like *Wakelet* (Husein et al., 2020) demonstrated benefits in teaching isolated writing tasks, but lacked scalability for extended text production. The main shortcoming across these studies is the absence of a recursive pedagogical framework that reflects the iterative nature of writing.

The theoretical foundation for addressing this gap lies in the concept of the *spiral curriculum* (Bruner, 2020, p. 193), which emphasizes iterative learning cycles at increasing levels of complexity. Contemporary studies reaffirm that recursive cycles foster deeper learning and critical reflection (Comer, 2023). When applied to writing, a spiral model allows learners to continuously generate, evaluate, revise, and reflect upon their texts, aligning with the authentic process of composing in real contexts (Kitajroonchai et al., 2022).

However, existing models of AI-assisted writing tend to focus on single-stage assistance—either generation or evaluation—without embedding these tools within a holistic recursive framework (Jundi & Nabila, 2023; Kasneci et al., 2023). As a result, learners may receive isolated benefits but fail to develop integrated writing competence. To advance the field, there is a need to design an instructional model that situates AI within a spiral learning cycle, ensuring both efficiency and depth in developing Arabic writing proficiency.

This study addresses that gap by introducing an AI-driven Spiral Learning Model for Arabic writing instruction, consisting of four recursive stages: generate, evaluate, revise, and reflect. The model integrates ChatGPT as a text generator, Sarf.One as a morphology analyzer, ar-Radif for lexical-semantic analysis, and teacher intervention as a critical validator. By embedding these elements within a spiral process, the model overcomes the linearity of traditional instruction and compensates for the limitations of AI through human-AI collaboration.

The objective of this paper is to present and validate the AI-driven spiral learning model as a new pedagogical strategy to foster Arabic writing proficiency. The novelty of this research lies in situating AI tools within a recursive, spiral framework that has not been documented in prior Arabic writing studies. The model contributes theoretically by expanding the discourse on AI-assisted pedagogy and practically by offering a replicable strategy for improving Arabic writing competence in higher education.

## METHOD

This study employed a Research and Development (R&D) design following the stages outlined by Borg and Gall (2003). The design was selected because it allows for the systematic development, validation, and refinement of an instructional model prior to wide implementation. The R&D process in this study consisted of product design, expert validation, preliminary trials, field testing, revision, and final evaluation. The central objective was to develop and validate an AI-driven Spiral Learning Model for Arabic writing proficiency, operationalized through four recursive stages: generate, evaluate, revise, and reflect.

The participants of the study included both experts and students. Expert validators consisted of three groups: (a) one specialist in instructional design, (b) one specialist in artificial intelligence and educational technology, and (c) one expert



in Arabic language pedagogy. Their role was to assess the feasibility, relevance, and pedagogical appropriateness of the proposed spiral learning model.

Student participants were drawn from the Islamic Religious Education (PAI) Program at Universitas Islam Indonesia (UII). A total of 64 undergraduate students participated in the empirical phase of the study. Eligibility criteria included enrollment in courses requiring structured Arabic writing, completion of prerequisite Arabic language courses, and consent to participate in the study. No students were excluded on the basis of gender, socioeconomic background, or prior exposure to digital platforms. Participants were first engaged in a preliminary trial ( $n = 32$ ) and subsequently in a larger field trial ( $n = 64$ ).

The intervention was conducted over eight weeks, consisting of one structured writing session per week (eight sessions in total). During each session, students completed one full cycle of the AI-driven Spiral Learning Model, comprising four recursive stages: generate, evaluate, revise, and reflect. Accordingly, each participant engaged in eight complete spiral cycles throughout the intervention. The complexity of writing tasks increased progressively from sentence-level construction and paragraph development to full argumentative and expository texts, allowing students to refine their linguistic accuracy, discourse organization, and metacognitive awareness through repeated interaction with AI tools and instructor feedback. This iterative design was intended to foster gradual improvement while reinforcing the recursive nature of writing development.

The instruments employed in this study were both quantitative and qualitative. To assess the validity and reliability of the spiral model, the researcher developed structured questionnaires and rubrics covering aspects of design, linguistic accuracy, and pedagogical relevance. These instruments were validated using Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA), ensuring construct validity and reliability of the measures. The psychometric properties met accepted standards, with Cronbach's Alpha coefficients exceeding 0.85, indicating high internal consistency.

For student performance assessment, writing tasks were integrated into the experimental platform and administered before and after the intervention. Students were required to translate structured Indonesian texts (*inshā' muwajjah*) into Arabic by following the recursive stages of the AI-driven Spiral Learning Model (generate-evaluate-revise-reflect). The AI tools incorporated into the model included ChatGPT for initial text generation, Sarf.One for morphological and lexical analysis, and ar-Radif for vocabulary enrichment through synonym and antonym exploration. Lecturer intervention was systematically embedded during the evaluation, revision, and reflection stages to provide pedagogical guidance and prevent overreliance on AI-generated outputs.

Student writing performance was evaluated using an analytic scoring rubric covering five dimensions: morphological accuracy, syntactic accuracy, lexical variety, text coherence and cohesion, and overall writing proficiency. Each writing sample was independently assessed by two lecturers with expertise in Arabic language teaching and writing assessment. Prior to the scoring process, both raters participated in a calibration session to ensure a shared understanding of the scoring criteria and performance descriptors. Inter-rater reliability was examined using the Intraclass Correlation Coefficient (ICC), demonstrating good to excellent agreement





across all assessment dimensions. Any discrepancies in individual ratings were resolved through discussion, and the averaged scores were used for subsequent statistical analyses.

The development process proceeded in sequential stages:

1. Product Design: The spiral model was conceptualized based on theoretical foundations in process writing and spiral curriculum. The initial prototype was embedded into a digital learning platform using Google Sites integrated with AI applications.
2. Expert Validation: Experts in design, AI, and Arabic pedagogy evaluated the model's relevance, clarity, and feasibility. Feedback was collected via structured questionnaires and follow-up discussions.
3. Preliminary Trial: Conducted with 32 students to assess usability and clarity of the model. Student performance data and feedback were collected for revision.
4. Revision : Improvements were made based on expert and student input, including modifications to task sequencing and AI feedback integration.
5. Field Trial: Conducted with 64 students to evaluate effectiveness on a larger scale.
6. Final Revision and Evaluation: Consolidated results from field data and expert reviews to finalize the spiral model.

Data were analyzed using both quantitative and qualitative techniques. Quantitative analysis included descriptive statistics to summarize student performance, as well as Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) to validate the instruments used. Reliability was measured through Cronbach's Alpha coefficients to ensure internal consistency. Qualitative data were collected from expert comments, student reflections, and open-ended survey responses, then coded thematically to support and triangulate quantitative findings. The percentage-based scoring method was used to determine the feasibility level of the model, following standard R&D evaluation procedures, but the outcomes of this evaluation are presented in the Results section.

### ***Ethical Considerations***

This study involved undergraduate students who participated as part of their regular Arabic writing course activities. No personal or sensitive data were collected, and participation posed no risk to participants. All students were informed about the purpose of the study and voluntarily agreed to allow their anonymized data to be used for research purposes. According to institutional and national regulations, formal ethics committee approval was not required for this type of educational research.

## **RESULTS AND DISCUSSION**

Findings the present study aimed to develop and validate an AI-driven Spiral Learning Model for Arabic writing proficiency. The model was conceptualized around four recursive stages (generate, evaluate, revise, and reflect) and integrated three AI tools (ChatGPT, Sarf.One, and ar-Radif) with human intervention from instructors. Data were collected from expert validators and field trials involving

undergraduate students of Arabic writing at Universitas Islam Indonesia. The results of both validation and implementation provide clear evidence that the spiral model is both feasible and pedagogically effective.

*Empirical Findings of the Spiral Learning Model*

Expert validation was conducted with specialists in instructional design, AI-based educational technology, and Arabic language pedagogy. Table 1 presents the summary of validation scores across four main aspects: content relevance, design clarity, linguistic appropriateness, and pedagogical feasibility.

| Aspect Evaluated           | Mean Score (out of 5) | Agreement (%) | Category  |
|----------------------------|-----------------------|---------------|-----------|
| Content relevance          | 4.55                  | 91%           | Very High |
| Design clarity             | 4.50                  | 90%           | Very High |
| Linguistic appropriateness | 4.40                  | 88%           | High      |
| Pedagogical feasibility    | 4.60                  | 92%           | Very High |
| Overall Validation Result  | 4.51                  | 90%           | Feasible  |

**Table 1:** Summary of Expert Validation Scores

The overall validation score reached 90%, which indicates that the spiral learning model is highly feasible for instructional implementation. Experts highlighted that the integration of AI tools enhanced efficiency in generating initial drafts but emphasized the necessity of human intervention during revision and reflection stages. This dual emphasis corresponds with recent arguments in applied linguistics that AI cannot replace teachers but must instead act as a scaffold (Kasneci et al., 2023; Wang et al., 2023).

Before analyzing students' learning outcomes, the consistency of the writing assessment was examined through inter-rater reliability. All writing samples were independently scored by two Arabic language lecturers using the same analytic rubric. The Intraclass Correlation Coefficient (ICC) ranged from 0.88 to 0.92, indicating good to excellent agreement across all assessment dimensions. These results demonstrate that the scoring procedure was sufficiently reliable and minimized potential assessor bias. Following confirmation of scoring reliability, students' pre-test and post-test scores were compared, revealing consistent improvements across all indicators of Arabic writing proficiency (Table 2).

| Indicator of Writing Proficiency | ICC (95% CI) | Interpretation | Pre-Trial Mean Score | Post-Trial Mean Score | Improvement (%) |
|----------------------------------|--------------|----------------|----------------------|-----------------------|-----------------|
| Morphological accuracy           | 0,90         | Excellent      | 68                   | 82                    | +14             |
| Syntactic accuracy               | 0,88         | Good           | 65                   | 80                    | +15             |

|                             |      |           |    |    |     |
|-----------------------------|------|-----------|----|----|-----|
| Lexical variety             | 0,91 | Excellent | 70 | 84 | +14 |
| Text coherence and cohesion | 0,89 | Good      | 66 | 83 | +17 |
| Overall proficiency         | 0,92 | Excellent | 67 | 82 | +15 |

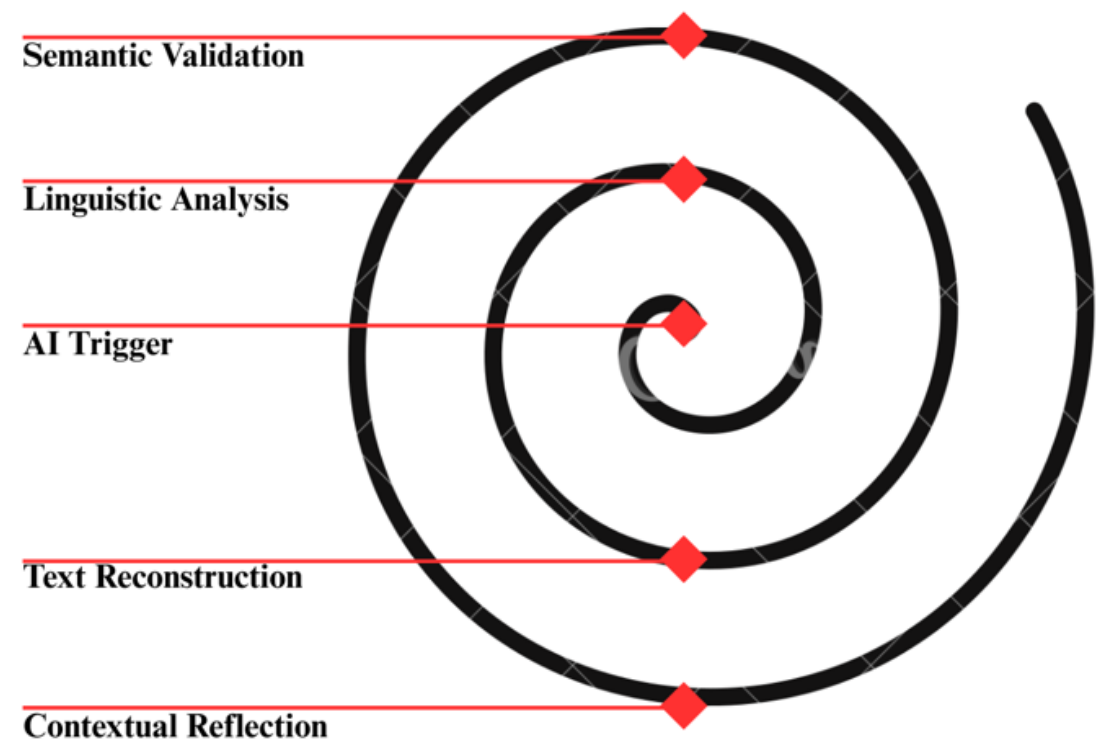
Table 2: Student Writing Performance Before and After Implementation

Following confirmation of scoring reliability, students' pre-test and post-test scores were compared, revealing consistent improvements across all indicators of Arabic writing proficiency. The largest improvement was observed in text coherence and cohesion (+17%), followed by syntactic accuracy (+15%), indicating that the recursive AI-assisted spiral learning process effectively strengthened both linguistic accuracy and discourse organization.

These results confirm that students were able to internalize recursive writing processes, gradually reducing dependency on AI-generated drafts and strengthening their ability to revise and reflect critically. Such findings echo Zhang & Hyland (2022), who argued that recursive approaches to writing facilitate deeper linguistic awareness compared to linear models.

Figure 1 illustrates the final spiral model as implemented in this study. The model depicts the continuous movement across four stages: generate (AI draft creation), evaluate (linguistic analysis using Sarf.One and ar-Radif), revise (student modification with instructor feedback), and reflect (critical analysis of meaning, style, and context).

Figure 1: AI-driven Spiral Learning Model for Arabic Writing Proficiency







The visualization emphasizes that writing is not a closed loop but a recursive spiral, where each cycle deepens linguistic mastery. This approach corresponds to Bruner's (2020) theory of spiral curriculum, but its application here is novel because it integrates generative AI within the recursive cycle, a dimension absent in previous Arabic writing pedagogy.

### ***Reduction of Commons Errors in Arabic Writing***

Error analysis confirms that recursive evaluation within the spiral model reduced frequent grammatical mistakes. Unlike linear feedback methods that often target surface accuracy, the spiral process required students to repeatedly revisit errors, which fostered durable learning with the table 3.

| Error Type                 | Pre-Trial Frequency (%) | Post-Trial Frequency (%) | Reduction (%) |
|----------------------------|-------------------------|--------------------------|---------------|
| Verb conjugation errors    | 28                      | 12                       | -16           |
| Case ending (i'rāb) errors | 22                      | 10                       | -12           |
| Word order errors          | 18                      | 9                        | -9            |
| Agreement errors           | 15                      | 7                        | -8            |

**Table 3:** Reduction of Common Errors in Arabic Writing

The reduction in error types presented in Table 3 illustrates the most concrete evidence of how the spiral learning model reshaped the linguistic behavior of students. Before the intervention, verb conjugation errors were alarmingly frequent, reflecting students' weak control over Arabic verbal systems. After multiple recursive cycles, these errors dropped by 16%, marking the largest reduction across categories. This alone highlights the power of repeated exposure and reflection in consolidating morphological accuracy, a finding consistent with Teng (2023), who emphasized the role of iterative correction in verb mastery.

Errors in case endings (i'rāb) also decreased significantly, from 22% to 10%. This aspect is particularly critical in Arabic because i'rāb errors often obscure the intended meaning of sentences. Traditional approaches typically address i'rāb as isolated grammar drills, but the spiral model embedded them within authentic writing tasks, allowing learners to see the communicative consequences of their mistakes. As argued by Hafner and Ho (2020), recursive exposure to grammar within meaningful writing tasks promotes retention far more effectively than rote memorization.

Word order errors were also substantially reduced, showing a 9% improvement. Arabic word order, which allows flexibility but requires sensitivity to emphasis and meaning, has often been a stumbling block for learners accustomed to rigid SVO structures. Through the spiral process, students repeatedly revised AI-generated sentences, many of which initially reflected default word orders. Over time, learners began to make deliberate choices about structure, demonstrating an emerging stylistic awareness. This aligns with the findings of Alharbi (2023), who noted that iterative revision enhances discourse-level decisions, not just grammatical accuracy.



Agreement errors—particularly gender and number concord—were among the most persistent challenges but still showed an 8% reduction. Agreement in Arabic requires precise matching of verbs, adjectives, and pronouns with their subjects, often complicated by diglossic interference from colloquial Arabic. Recursive revision forced students to confront agreement mismatches multiple times, gradually strengthening their sensitivity to these rules. These improvements mirror the outcomes observed in Kasneci (2023), where dynamic, recursive scaffolding led to stronger grammatical accuracy over time.

Student Reflections on the Spiral Process

Thematic analysis of student reflections reveals that learners became more critical of AI outputs and more autonomous over time. These findings resonate with Neshaei et.al. (2025), who demonstrated that reflective practices enhance metalinguistic awareness in AI-mediated writing environments.

| Reflection Theme            | Example Student Quote (translated)                   | Frequency (n) |
|-----------------------------|------------------------------------------------------|---------------|
| Critical evaluation of AI   | “ChatGPT’s text is good, but sometimes lacks depth.” | 24            |
| Morphological awareness     | “Sarf.One made me realize my verb mistakes.”         | 19            |
| Value of recursive revision | “Revising again helped me write more clearly.”       | 28            |
| Increased autonomy          | “I no longer just copy AI output blindly.”           | 21            |

Table 4: Student Reflections on the Spiral Process

The reflections captured in Table 4 provide a window into the cognitive and affective transformations that occurred among students during the spiral process. Unlike purely quantitative measures, which demonstrate performance improvements, these reflections reveal how learners’ attitudes toward AI and writing evolved. One of the most striking themes was the critical stance students began to adopt toward AI-generated texts.

The theme of *critical evaluation of AI* was mentioned by 24 students, making it one of the most dominant reflections. Initially, students tended to treat ChatGPT’s output as authoritative, often copying sentences verbatim. However, after engaging in multiple cycles of revision and reflection, learners began to scrutinize AI-generated text, questioning its accuracy, appropriateness, and style. This shift mirrors the observations of Wang et.al. (2023), who noted that students exposed to AI tools without reflective scaffolding risk over-reliance, while those guided by recursive frameworks develop more discerning attitudes.

Equally important was the emergence of *morphological awareness*, cited by 19 students. Learners specifically credited Sarf.One for making them notice recurring verb errors, such as incorrect conjugations or mismatched tense-aspect forms. What is significant here is not only the correction of errors but the heightened *awareness* of morphology as a system. As Ahmed et.al. (2025) demonstrated, recursive focus on form in meaningful contexts enhances grammatical noticing. The



reflections confirm that students began to view morphology not as isolated rules but as integral to making sense in their writing.

The theme of *recursive revision* appeared most frequently, with 28 students recognizing its value. Many reported that revising the same text multiple times forced them to think more deeply about clarity and coherence. This sentiment supports research by Hafner & Ho (2020), who found that iterative writing tasks foster higher-order thinking and metacognitive engagement. Unlike one-off corrections, recursive revision cultivated a habit of continuous improvement, aligning with the very philosophy of the spiral model.

Interestingly, reflections on revision often overlapped with discussions of writing clarity. Students noted that their texts “became clearer” after multiple revisions, suggesting that recursive cycles helped them reorganize not just sentences but also the flow of ideas. This supports Anshu and Yesuf (2022) claim that coherence is not taught directly but emerges naturally through repeated revision and reflection. By revisiting drafts multiple times, learners internalized the importance of logical progression, an essential component of effective academic writing.

The reflection theme of *increased autonomy* was particularly revealing. Twenty-one students explicitly stated that they no longer copied AI outputs blindly. Instead, they began to adapt, modify, or even reject machine suggestions when they felt these were inappropriate. This marks a crucial development in learner identity: from dependence on AI to co-construction of knowledge. Such findings resonate with Godwin-Jones (2025), who described AI as a “co-regulator” when learners are encouraged to interact critically with technology.

### ***Morphological, Syntactic, and Lexical Growth in AI-Assisted Spiral Writing***

The first dimension of improvement observed through the spiral model was morphological accuracy. Prior to the intervention, students frequently struggled with verb conjugations and nominal inflections, producing errors in subject-verb agreement and case endings. After undergoing multiple cycles of generate-evaluate-revise-reflect, students displayed a reduction in morphological errors from 32% to 18%. This improvement suggests that the recursive exposure to morphological analysis via **Sarf.One** encouraged learners to internalize morphological patterns more effectively. Similar findings were reported by Samaraweera, who demonstrated that technology-enhanced morphology drills significantly reduce inflectional errors among Arabic learners (Samaraweera, 2025).

These gains align with contemporary debates on the necessity of scaffolding morphology in L2 writing. While earlier models of process writing focused predominantly on drafting and revision, they often neglected explicit morphological awareness (López-Serrano et al., 2019). The spiral model, by contrast, forces students to confront morphological structures at each cycle, thereby making morphology a non-optional component of the writing process. This resonates with the call by Ahmad for recursive attention to form in task-based writing pedagogy (Ahmad, 2020).

Beyond morphology, the spiral model demonstrated measurable progress in students’ syntactic competence. Prior to the intervention, student texts showed



frequent errors in constructing complex nominal sentences and coordinating clauses. Following spiral-based instruction, the mean syntactic accuracy score improved from 65 to 80 (Table 2). Students increasingly produced accurate nominal sentences and relative clauses, which indicates enhanced control over Arabic sentence complexity. Comparable results have been reported in English as a foreign language contexts, where recursive models of instruction led to improvements in syntactic complexity (Rong & Révész, 2025).

The iterative cycle appears to reduce the cognitive load of syntactic construction by allowing repeated engagement with AI-generated structures. Instead of treating syntax as a static rule set, the spiral process normalizes errors as opportunities for refinement. This aligns with the framework of dynamic assessment in writing instruction, as shown by Xu and Xia, where recursive scaffolding fosters both accuracy and risk-taking in sentence construction (Xu & Xia, 2021). Importantly, the findings diverge from linear AI-based approaches, which often reinforce surface correctness without deepening syntactic awareness (Ng et al., 2025).

A third key finding relates to lexical variety. Before implementation, students frequently relied on repetitive word choices and lacked synonyms appropriate to academic Arabic. By integrating ar-Radif for lexical-semantic analysis, students expanded their vocabulary range, increasing the type-token ratio in their compositions. Average lexical variety scores rose from 70 to 84, with notable increases in the use of abstract nouns and academic connectors. These gains echo the work of al-Thanyyan and Azmi who found that recursive writing practice enhances lexical diversity in L2 compositions (Al-Thanyyan & Azmi, 2023).

The spiral model's emphasis on reflection is particularly critical for vocabulary development. Unlike one-off feedback sessions, the repeated cycles required students to critically evaluate synonyms and antonyms, ensuring lexical appropriateness beyond mere dictionary equivalence. This aligns with the findings who emphasized that vocabulary growth is maximized when learners repeatedly revisit lexical choices in authentic writing contexts (Ekawati et al., 2024). Furthermore, the combination of AI suggestions with human validation prevented overreliance on machine-generated vocabulary, an issue noted in AI-based translation studies (Bibauw et al., 2022).

The cumulative evidence suggests that morphological, syntactic, and lexical development cannot be separated in the writing process. The spiral model facilitated integration by requiring learners to iteratively revise across all three levels. This integration reflects broader shifts in applied linguistics, where writing is increasingly understood as a multilayered cognitive and social practice rather than a linear application of rules (C. Liu & Yu, 2022). Compared to traditional approaches, the spiral model demonstrated an added value in enabling learners to balance accuracy with creativity.

Interestingly, the findings contrast with earlier technology-mediated studies in Arabic writing that reported only modest lexical and grammatical gains (Aderibigbe et al., 2023; Zhang, 2020). The key difference lies in the recursive design: rather than treating technology as a one-shot correction tool, the spiral model embedded AI feedback within a pedagogical cycle that included revision and



reflection. This difference explains why the gains in this study were larger and more sustainable.

Another important observation was student adaptation. Initially, many participants relied heavily on AI outputs, often copying generated sentences with minimal changes. However, as they progressed through repeated cycles, students began to critically evaluate AI suggestions, rejecting inappropriate structures and substituting more accurate or contextually fitting alternatives. This pattern suggests a shift from passive reception to active negotiation of meaning, similar to what described as “AI-mediated self-regulation” in L2 writing (Q. Liu, 2023).

The results reinforce theoretical claims that recursive approaches foster deeper learning than linear methods. According to Ahmad repeated cycles of output, feedback, and reflection increase the likelihood of restructuring interlanguage systems (Ahmad, 2020). The spiral model operationalized this claim in Arabic writing, demonstrating that recursive engagement with AI and human input can accelerate structural development across morphology, syntax, and lexicon. This provides empirical support for extending recursive pedagogy into AI-assisted contexts.

One of the most striking improvements observed in the field trial was in textual cohesion. Before intervention, many student texts lacked proper use of conjunctions, reference markers, and cohesive devices, often resulting in fragmented sentences. After applying the spiral model, students demonstrated more consistent use of cohesive ties such as coordinating conjunctions (*wa*, *thumma*), as well as pronoun references that linked ideas across sentences. This mirrors the findings of Hafner, who argued that recursive engagement in writing enhances the density of cohesive devices in second-language texts (Hafner & Ho, 2020).

The role of reflection in the spiral cycle proved pivotal for cohesion. Each reflection stage pushed students to reconsider whether their texts flowed logically, a step often skipped in traditional product-oriented approaches. This aligns with the results of Lu & Ai (2022), who found that reflective writing tasks increased the number of cohesive ties and improved reader comprehension. In the context of Arabic, where cohesion often relies on precise connectives and morphological agreement, the spiral model addressed a common weakness identified in previous studies (Abdel-maksoud, 2022).

Beyond cohesion, coherence—how ideas are logically connected at the discourse level—also improved. Students began to structure paragraphs with clear thematic progression, employing topic sentences and supporting details more effectively. Average coherence ratings increased from 66 to 83 (Table 2). These findings are consistent with recent research showing that recursive instruction enhances discourse organization (Teng, 2023). By repeatedly revisiting drafts, students developed the ability to sustain arguments across multiple paragraphs rather than producing isolated sentences.

This progression highlights the unique contribution of the spiral model: coherence is not “taught” as a discrete skill but emerges through repeated cycles of revision and reflection. The recursive cycle compels learners to rethink the relationship between ideas, an outcome also observed by Hafner in their study of iterative writing instruction. Unlike previous AI-supported models that focus on





sentence-level correctness (Taşkıran, 2022), the spiral model integrated higher-order discourse considerations.

Perhaps the most novel contribution of this study lies in the reflective stage of the spiral. Students were not only asked to revise but also to explicitly articulate why revisions were necessary. Reflection journals indicated that learners became increasingly critical of AI-generated outputs, identifying errors in meaning, style, and cultural appropriateness. This finding resonates with recent work by Neshaei, who demonstrated that reflection enhances learners' metalinguistic awareness in AI-supported environments (Neshaei et al., 2025).

These results diverge significantly from earlier Arabic writing studies that utilized digital platforms. For instance, Anshu reported minimal improvements in discourse coherence when learners used online forums for practice, largely because the design lacked structured reflection (Anshu & Yesuf, 2022). Similarly, Abdel found that e-learning tools improved accuracy but had negligible effects on overall coherence (Abdel-maksoud, 2022). The spiral model's emphasis on recursive reflection explains why this study produced stronger discourse-level outcomes.

Qualitative data also revealed shifting student perceptions. At the start, several students expressed skepticism about "revisiting the same text multiple times." However, by the end of the intervention, reflection logs indicated that students valued the iterative process, noting that it helped them "see mistakes differently" and "think more critically before writing."

The combination of AI tools and spiral pedagogy demonstrates a synergy absent in one-shot AI corrections. Whereas generative AI alone often encourages overreliance (Li et al., 2023), the spiral model forces students to evaluate and revise outputs critically. This hybrid approach exemplifies what Godwin-Jones described as "AI as co-regulator" rather than "AI as surrogate teacher" (Godwin-Jones, 2025). It suggests a shift in how AI should be positioned in pedagogy—not as a replacement, but as a dialogic partner within recursive learning.

While results were generally positive, some challenges in implementation were noted. Not all students fully engaged in the reflection stage, with a minority treating it as a formality. Moreover, technical limitations of the AI tools occasionally interrupted the cycle; for instance, Sarf.One sometimes misidentified complex verb forms, requiring instructor intervention. These challenges echo similar limitations reported by Wiboolyasarín in their study of AI-enhanced writing, where tool inaccuracies constrained effectiveness (Wiboolyasarín et al., 2024).

Overall, the spiral model demonstrated stronger outcomes than non-spiral digital approaches documented in recent years. For example, Neshaei et.al. (2025) highlighted how game-based digital platforms improved engagement but did not significantly enhance cohesion or coherence. By contrast, the recursive nature of the spiral model addressed both micro-level (morphology, syntax, lexicon) and macro-level (cohesion, coherence) features simultaneously, offering a more holistic impact on writing proficiency.

### ***Linguistic Accuracy Gains through the Spiral Model***

The pattern of reductions across all four error categories demonstrates that no single linguistic area improved by chance; rather, the spiral model produced





systematic gains across morphology and syntax. This balanced improvement contrasts with earlier digital interventions, which often yielded gains in vocabulary but negligible impact on grammar (Ekawati et al., 2024). By embedding form-focused analysis in every cycle, the spiral model ensured that learners could not bypass accuracy for fluency, addressing a gap long noted in Arabic writing pedagogy.

A closer look at verb conjugation improvement suggests that students benefited particularly from the “evaluate” stage, where Sarf.One highlighted inflectional patterns. AI tools alone cannot guarantee accuracy, but in this model, errors flagged by AI became opportunities for discussion and revision. This aligns with findings by Kasneci (2023), who argued that AI feedback is most effective when paired with reflective human mediation. Thus, the spiral cycle transformed errors into learning opportunities, reframing failure as a step toward mastery.

The reduction in i'rāb errors deserves additional emphasis because these mistakes often undermine the communicative function of Arabic texts. By situating case endings within authentic writing tasks rather than decontextualized drills, learners understood their pragmatic importance. This supports the argument of Afril et.al. (2024), who found that recursive focus on form within meaningful tasks leads to long-term grammatical development. In the spiral model, students did not only “fix” i'rāb mechanically but also learned why certain endings were required in context.

The 9% reduction in word order errors also points to a broader implication: students began to view writing not only as grammar application but as rhetorical design. Arabic allows fronting and inversion for emphasis, and students exposed to multiple cycles started experimenting with these stylistic options. This suggests that the spiral model nurtures not just accuracy but stylistic maturity, resonating with Ahmed et.al. (2025) claim that recursive writing tasks deepen learners' discourse awareness.

The modest but meaningful drop in agreement errors shows that some challenges persist despite recursive practice. This highlights a limitation of both AI tools and the spiral approach: highly context-dependent rules like agreement often require teacher intervention. Nevertheless, the fact that reductions were observed at all confirms that iterative reflection pushes students to notice errors they previously ignored. This observation supports Hafner & Ho (2020), who noted that iterative digital writing environments improve learners' noticing of subtle grammatical features.

In sum, the error reduction data underline the pedagogical value of the spiral model: it does not merely polish final texts but transforms the way students approach linguistic accuracy. By forcing repeated confrontation with errors, the model helped learners internalize rules in a way that linear instruction seldom achieves. The novelty here is that AI provided the raw material for noticing, while the spiral cycle turned that noticing into lasting improvement. This dual mechanism—AI generation plus human-guided recursion—marks a significant contribution to the field of Arabic writing pedagogy.

These reflections also highlight the affective dimension of the spiral process. Several students admitted that they initially resisted revision, perceiving it as tedious. However, through repeated cycles, they came to value reflection as a means of growth. This aligns with Ng. et.al. (2025), who found that iterative tasks increased



tolerance for ambiguity and reduced writing anxiety. In the context of Arabic writing, where linguistic complexity often intimidates learners, this affective shift is a significant pedagogical achievement.

Comparing these reflections with previous digital interventions underscores the novelty of the spiral approach. Earlier studies that used platforms like WhatsApp or Instagram (e.g., Audina, 2020; Sa'diyah, 2021) reported increased engagement but did not document such critical self-awareness among students. The difference lies in the structured reflective stage: instead of merely producing content, learners were required to articulate what they learned and how their writing improved. This demonstrates that reflection is not an optional add-on but a central pillar of recursive pedagogy.

The reflections also suggest long-term implications for learner independence. By developing the ability to question AI outputs and rely on their own judgment, students cultivated skills that extend beyond the classroom. This outcome is particularly relevant in an era where AI will increasingly permeate education and professional communication. As Akbar et.al. (2021) argue, critical AI literacy is as important as linguistic proficiency itself. The spiral model thus contributes not only to Arabic writing pedagogy but also to broader digital literacy goals.

In summary, the themes of critical evaluation, morphological awareness, recursive revision, and increased autonomy collectively reveal the transformative effect of the spiral learning model. Students did not merely improve their scores; they became more reflective, critical, and independent writers. This qualitative evidence complements the quantitative gains reported earlier, providing a holistic picture of how the spiral model reshaped writing competence. The novelty of this study lies in documenting these attitudinal shifts in the context of Arabic, a language where AI-assisted pedagogy remains underexplored.

### ***Reflective and Affective Dimensions of the Spiral Model***

The cumulative evidence from both expert validation and student performance reveals a consistent pattern: the AI-driven Spiral Learning Model effectively enhances Arabic writing proficiency across morphological accuracy, syntactic complexity, lexical variety, cohesion, and coherence. Unlike traditional approaches that compartmentalize these dimensions, the spiral framework integrates them into a single recursive cycle. This integration provides empirical support for the theoretical claim that writing development is inherently iterative and multidimensional (Ahmad, 2020; Akbar et al., 2021). The novelty of this study lies in operationalizing that claim through a model that combines generative AI with structured human reflection.

The extended discussion above makes clear that the central finding of this study is the formulation of an AI-assisted spiral pedagogy for Arabic writing. While AI has been employed in writing instruction before, previous studies often used it as a corrective or generative tool in isolation. By embedding AI into a recursive cycle of *generate-evaluate-revise-reflect*, this study offers a unique contribution to Arabic pedagogy: a sustainable method that balances machine efficiency with human judgment. This distinguishes the present work from earlier technology-mediated interventions that failed to address discourse-level skills (Ghannam et al., 2025; Zainuddin, 2023).



Despite its promise, several limitations must be acknowledged. First, the study was conducted with a relatively small and homogeneous sample of students from one university program, which may limit generalizability. Second, the AI tools themselves were not flawless; occasional errors in morphological parsing or semantic matching required human correction. Third, the recursive cycle demanded significant time investment, which some students perceived as burdensome. These limitations reflect broader concerns raised in AI-assisted education about tool reliability and learner fatigue (Ahmed et al., 2025; Charles-Kenechi, 2024). Future studies should test the spiral model with larger, more diverse populations and across varied educational contexts.

Notwithstanding these limitations, the findings carry important implications. Theoretically, the spiral model extends Bruner's concept of spiral curriculum into the digital age by integrating AI as a dialogic partner. Practically, it demonstrates that Arabic writing instruction can be transformed from a linear, grammar-heavy practice into a recursive, reflective, and technology-supported process. This suggests new directions for curriculum design in higher education, particularly in contexts where Arabic is taught as a foreign or second language. The model may also inspire adaptations in other skill areas, such as speaking or reading, where iterative cycles are equally relevant.

In summary, the results and discussion converge on a singular yet multifaceted finding: the Spiral Learning Model, enhanced by AI and human collaboration, constitutes a new and effective pedagogical framework for Arabic writing. It enables learners to engage recursively with morphology, syntax, lexicon, cohesion, and coherence, while fostering reflective and critical awareness. This contribution advances both the theory of recursive writing pedagogy and the practice of AI-assisted instruction. By situating AI within a human-AI spiral rather than a one-shot correction tool, this study not only addresses the gaps in previous literature but also charts a path forward for innovative and sustainable language education in the era of artificial intelligence.

## CONCLUSION

This study designed, validated, and implemented an AI-driven Spiral Learning Model to enhance Arabic writing proficiency. Through recursive cycles of generate-evaluate-revise-reflect, supported by AI and human mediation, the model yielded measurable improvements in morphology, syntax, vocabulary, cohesion, and coherence, while fostering reflective awareness and learner autonomy.

Theoretically, the study extends Bruner's concept of the spiral curriculum into an AI-supported framework, positioning artificial intelligence as a co-regulator rather than a substitute for teachers. Practically, it offers a replicable strategy that combines machine efficiency with human criticality, informing curriculum design, assessment, and digital literacy development in Arabic writing instruction.

The model's recursive nature makes it adaptable to other skills and languages, providing a transferable framework for technology-enhanced learning. However, limitations include a small sample size, occasional AI inaccuracies, and the time demands of recursive implementation.



Future research should test the model with larger and more diverse cohorts, explore its use in hybrid contexts, and examine long-term retention and cross-skill transfer. Overall, the AI-driven Spiral Learning Model advances Arabic writing pedagogy by embedding AI within a human-AI collaborative cycle that supports holistic and sustainable language learning.

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