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On the Effectiveness of Etymological Elaboration mitigated with AI-based Instruction on Idiom learning of EFL Students

ABSTRACT

This study investigated the effectiveness of etymological elaboration integrated with AI-based tools on idiom learning among 60 upper-intermediate Iranian EFL learners, using a quasi-experimental pretest-posttest design. Participants, selected via the Oxford Quick Placement Test for homogeneity, were randomly assigned to three groups: Experimental Group 1 (AI + Etymology), Experimental Group 2 (Etymology Only), and a Control Group (Traditional Instruction). Over six weeks, Experimental Group 1 received AI-supported instruction with personalized mnemonic aids and interactive narratives, Experimental Group 2 used traditional etymological methods, and the Control Group focused on rote memorization. Idiom knowledge was assessed through a 50-item test (25 recognition, 25 production items). Results showed significant differences in posttest scores, with Experimental Group 1 outperforming Experimental Group 2 and the Control Group. Tukey's HSD test confirmed significant group differences. These findings highlight the synergistic potential of AI-driven tools and etymological elaboration in enhancing idiom acquisition, offering implications for innovative, culturally informed EFL pedagogy. The pedagogical implications are discussed.

Keywords: AI-based instruction, etymological elaboration, idiom learning, dual coding theory

Introduction

Idiomatic expressions represent one of the most complex yet indispensable aspects of second language (L2) learning, forming a critical link between linguistic competence and cultural literacy. They embody figurative meanings that often diverge from literal interpretations, thereby challenging learners to navigate beyond word-for-word translation. Despite decades of inquiry, idioms continue to occupy a contested space in second language acquisition research, where debates persist regarding their teachability, retention, and the most effective pedagogical approaches (1). While some early views suggested idioms

should be relegated to advanced stages of instruction due to their opacity, more recent perspectives underscore their centrality in authentic communication, intercultural competence, and pragmatic fluency (2, 3).

Scholarly interest in idiomatic acquisition has been spurred by several intersecting domains, including cognitive linguistics, psycholinguistics, and applied linguistics. Cognitive theories, notably Paivio's dual coding framework, argue that idiom comprehension and retention are facilitated when learners are exposed to both verbal and non-verbal cues, enabling mental imagery alongside semantic processing (4). Such dual processing perspectives align with research demonstrating that etymological elaboration—explaining idioms through their historical origins or conceptual metaphors—promotes deeper cognitive engagement and longer-term recall (5-7). These findings contrast with purely literal or rote memorization approaches, which often lead to shallow processing and poor retention rates (8).

The challenge of idiom learning is compounded by issues of transfer and cross-linguistic similarity. Idioms frequently defy direct translation, and in many cases learners attempt to calque or transfer idiomatic meaning from their native language, with mixed results (9). Cross-linguistic studies indicate that idioms with high transparency or cultural overlap are more easily acquired, whereas opaque idioms remain persistently difficult (10). Research on contextualized input further emphasizes the need to integrate idioms within meaningful cultural and communicative contexts, where learners can infer pragmatic and metaphorical meanings through usage rather than decontextualized memorization (11, 12).

The role of technology and artificial intelligence (AI) has become increasingly salient in supporting idiomatic learning and broader L2 pedagogy. Intelligent tutoring systems now offer adaptive scaffolding that responds to learner errors, while AI-driven platforms simulate contextual encounters with idiomatic usage (13, 14). The integration of natural language processing tools in language learning applications has further advanced automated idiom recognition, feedback, and practice opportunities (15). As educational AI continues to expand, reviews highlight both its transformative potential and the challenges of reliability, transparency, and pedagogical alignment (16, 17). Scholars such as Shin (18) argue that AI is reshaping English language education by augmenting teachers' capacity to deliver individualized and contextualized learning experiences.

Mobile-assisted and web-based approaches are another frontier in idiom instruction. Early frameworks for mobile learning emphasized content delivery, but subsequent developments expanded toward collaborative and interactive models (19). Later frameworks have proposed evaluative tools for mobile learning resources, highlighting criteria such as adaptability, learner autonomy, and situated practice (20). More recent studies demonstrate that web-based platforms and digital tools can significantly enhance idiom learning outcomes, particularly when designed around multimedia input and interactive exercises (21). These digital literacy dimensions reinforce the necessity of equipping learners not only with language skills but also with the digital competencies required for navigating technology-enhanced environments (22).

Another significant debate concerns the methodological rigor of idiom research in L2 studies. While the field has seen robust growth, concerns have been raised regarding the lack of replication and methodological diversity. McManus (23) identifies replication studies as crucial for validating findings and ensuring cumulative knowledge in idiom research. Similarly, reviews of the methodological landscape call for triangulated approaches that integrate qualitative insights, experimental evidence, and technological innovations to capture the complexity of idiom acquisition (1).

Pedagogically, idiom instruction has drawn on multiple approaches. Some scholars advocate cognitive linguistic approaches that emphasize metaphor awareness, mental imagery, and etymological links (5, 24). Others highlight social and collaborative learning contexts, where group interaction fosters deeper negotiation of idiomatic meaning (25). Comparative studies examining etymological versus literal instruction often report no significant differences in retention of idiom constituents, underscoring the multifaceted nature of idiom learning (8). However, multimodal approaches—such as combining images, stories, and humor with etymological explanations—appear to synergistically enhance retention and learner motivation (7).

Motivation, indeed, emerges as a recurrent factor influencing idiom acquisition. Learners' willingness to engage with figurative language is often linked to their intrinsic motivation, self-efficacy, and perceived relevance of idioms in authentic communication (26). In many cases, idioms are viewed as peripheral or overly advanced, leading to learner resistance and disengagement. However, when integrated meaningfully into curricula, idioms can bolster learners' communicative confidence, cultural understanding, and pragmatic fluency (2, 3).

The rise of AI and machine learning also necessitates revisiting the conceptual foundations of idiom instruction. Foundational works in artificial intelligence highlight its broader applicability in education and human-computer interaction (27-29). Subsequent contributions underscore AI's role in personalizing learning trajectories, optimizing instructional delivery, and providing adaptive feedback in language learning contexts (30, 31). Within idiomatic learning, AI-driven systems are now being designed to recognize learners' metaphorical reasoning patterns, suggest corrective feedback, and even generate culturally authentic idiomatic input (14, 17).

Nevertheless, technology integration is not without its challenges. Issues such as teacher preparedness, infrastructural limitations, and learner digital divides complicate implementation (32). Additionally, concerns remain about the extent to which technological solutions can authentically capture the cultural nuances and pragmatic dimensions of idioms, which are deeply embedded in sociocultural contexts (11). These challenges underscore the need for a balanced approach that leverages technological innovation while grounding instruction in cultural and communicative realities.

Etymological elaboration continues to attract scholarly attention, not only as a memory aid but also as a bridge between linguistic form, cultural history, and conceptual metaphor (5, 24). Research indicates that tracing idioms back to their origins can demystify opaque expressions, offering learners a narrative or conceptual framework that facilitates understanding (6). Moreover, studies integrating humor, imagery, and storytelling with etymological explanations highlight the synergistic benefits of multimodal elaboration (7). Despite such promise, other investigations caution that etymological knowledge alone may not guarantee retention or transfer, particularly in contexts where learners are more focused on immediate communicative needs (8).

In synthesizing these strands, it becomes evident that idiom learning represents a multidimensional challenge requiring integration of cognitive strategies, motivational scaffolds, technological affordances, and methodological rigor. Idioms encapsulate cultural worldviews, conceptual metaphors, and pragmatic routines, making their acquisition essential for authentic communication yet inherently complex. Advances in AI and digital learning environments have expanded the pedagogical toolkit, offering novel opportunities for contextualized practice, adaptive feedback, and etymological exploration (13, 15, 18). At the same time, replication studies and methodological reviews caution against overgeneralization, calling for more robust, triangulated evidence (1, 23).

This study is situated at the intersection of these debates, examining the effectiveness of etymological elaboration in idiom learning within technology-enhanced contexts.

Methods and Materials

Participants

This study adopted a quasi-experimental pretest-posttest design with control and experimental groups. A pilot study was conducted four months prior to the main study to refine the research methodology, optimize the integration of AI-driven tools with etymological elaboration, and identify potential design flaws. The pilot study involved 12 upper-intermediate EFL learners (aged 20–27, male and female) enrolled in an English language course at Ava language center in Tehran, Iran. The pilot phase

helped determine the optimal number of idioms, the format of AI-generated content (e.g., interactive narratives and mnemonic visualizations), and the duration of instructional sessions to maximize engagement and learning outcomes. For the main study, 80 upper-intermediate EFL students from the same language center were initially recruited. The Oxford Quick Placement Test (OQPT) was administered to ensure participant homogeneity, with 20 students excluded for scores deviating one standard deviation above or below the mean, resulting in a final sample of 60 participants. These participants were randomly assigned to two experimental groups ($n=20$) and one control group ($n=20$). The first experimental group received idiom instruction through etymological elaboration integrated with AI-based tools, including adaptive learning platforms that provided personalized mnemonic aids, contextualized narratives, and real-time feedback on idiom usage. The other group received etymology elaboration without AI tool, and the control group as a traditional idiom instruction focused on rote memorization and contextual examples without AI support or etymological elaboration.

Instruments

Oxford Quick Placement Test

The Oxford Quick Placement Test (OQPT), developed by Cambridge ESOL and Oxford University Press, is a trusted tool for assessing English proficiency, validated with over 6,000 students across 20 countries. This study used the paper version, which has two parts: questions 1–40 and 41–60. The 60 multiple-choice questions cover vocabulary, grammar, and cloze tasks, giving a clear snapshot of participants' general English skills to ensure they're at a similar level. Designed by Allen (1992), version 2 of the OQPT was used, with 60 minutes allotted for completion. Its reliability is strong, with a reported Cronbach's Alpha of .809, and score distribution met normality assumptions (skewness and kurtosis within ± 1.96 of standard errors). Administered at the start of the study, the OQPT ensured participant homogeneity.

Pretest and Posttest in Idioms

The assessment protocol consisted of a pretest and posttest to measure participants' receptive and productive knowledge of target idioms, selected based on their frequency in English discourse (e.g., from the Corpus of Contemporary American English) and their clear etymological origins (e.g., "spill the beans," "kick the bucket"). Each test included 50 items, divided equally into two sections: 25 multiple-choice items (each worth 1 point) to assess idiom recognition and 25 fill-in-the-blank items (each worth 1 point) to evaluate idiom production. The tests were identical in structure and content to ensure comparability, with items randomized to mitigate order effects. The reliability of the posttest was calculated using Cronbach's alpha, yielding a coefficient of 0.72 for the overall test (0.75 for the recognition section and 0.70 for the production section), indicating acceptable internal consistency for research purposes. To enhance scoring reliability, the fill-in-the-blank items were evaluated by two independent raters using a standardized rubric (exact match = 1 point, incorrect or incomplete = 0 points), with an interrater reliability of 0.92 (Cohen's kappa).

Procedure

The study was conducted over a 10-week period, including a pilot phase, participant selection, intervention, and assessments, following a quasi-experimental pretest-posttest design with two experimental groups and one control group. After ensuring homogeneity of the learners and dividing the intact classes into three groups, the treatment started. The first group received instruction combining etymological elaboration with AI-driven tools. Lessons included brief explanations of each idiom's historical or cultural origin (e.g., "read between the lines" linked to cryptographic practices; Terban, 1996) delivered via an AI-

based platform. The platform, adapted from open-source natural language processing tools, generated personalized mnemonic aids (e.g., animated visualizations of idiom origins, such as a sword hanging by a thread for “hanging by a thread”), interactive contextual narratives (e.g., dialogues embedding idioms), and real-time feedback on idiom usage during practice exercises. Each session began with a 10-minute introduction to 2–3 idioms’ etymologies, followed by 30 minutes of AI-supported activities (e.g., matching idioms to visualized origins, completing AI-generated sentences) and 20 minutes of guided practice with instructor feedback.

The second experimental group (Etymological Elaboration without AI Tools) received etymological elaboration through traditional methods. Instructors provided detailed explanations of idiom origins using printed materials and slideshows (e.g., referencing the biblical roots of “cast pearls before swine”). Sessions followed a similar structure: 10 minutes of etymological explanation, 30 minutes of paper-based activities (e.g., matching idioms to meanings, writing sentences), and 20 minutes of group discussion and instructor-led feedback. No AI tools were used, ensuring a direct comparison of etymological elaboration delivery methods.

The control group received conventional idiom instruction focusing on rote memorization and contextual examples. Instructors introduced idioms with dictionary definitions and example sentences, followed by activities such as memorizing meanings, completing worksheets, and role-playing dialogues. Sessions were structured identically to the experimental groups (10-minute introduction, 30-minute activities, 20-minute practice) but lacked etymological content or AI support. To ensure consistency, all instructors followed a standardized lesson plan. Attendance was monitored, and participants absent for two or more sessions were excluded; no participants were excluded due to full attendance. Quantitative data from the pretest and posttest were analyzed using ANOVA to examine the effects of treatment on idiom learning.

Findings and Results

The research question investigated the effectiveness of etymological elaboration integrated with AI-based instruction, etymological elaboration without AI, and traditional instruction on idiom learning among upper-intermediate Iranian EFL learners. A quasi-experimental pretest-posttest design was employed, with participants’ overall idiom knowledge (combining recognition and production) assessed through a 50-item test (25 multiple-choice items for recognition and 25 fill-in-the-blank items for production, each worth 1 point). Descriptive statistics for the pretest and posttest, along with a one-way ANOVA and post-hoc comparisons, are presented below to evaluate differences in performance across the three groups: Experimental Group 1 (etymological elaboration with AI-based tools), Experimental Group 2 (etymological elaboration without AI), and the Control Group (traditional instruction). The pretest was administered to establish baseline performance across the three groups. Table 1 presents the descriptive statistics for the pretest scores, reflecting overall idiom knowledge (out of 50 points).

Table 1. Descriptive Statistics of Pretest for Idiom Knowledge

Group	N	Mean	Std. Deviation	Minimum	Maximum
Experimental Group 1 (AI + Etymology)	20	14.85	1.72	12.00	17.00
Experimental Group 2 (Etymology Only)	20	14.65	1.69	12.00	17.00
Control Group	20	14.30	1.75	11.00	16.00

As shown in Table 1, the pretest scores for idiom knowledge were similar across groups, with Experimental Group 1 ($M = 14.85$, $SD = 1.72$), Experimental Group 2 ($M = 14.65$, $SD = 1.69$), and the Control Group ($M = 14.30$, $SD = 1.75$) exhibiting comparable means and variability. The slight differences in mean scores (ranging from 14.30 to 14.85) suggest minimal pre-existing differences in idiom knowledge prior to the intervention. A one-way ANOVA conducted on pretest scores confirmed no significant differences between groups ($F(2, 57) = 0.614$, $p = 0.544 > 0.05$), ensuring group equivalence at the start of the

study. Following the six-week intervention, a posttest was administered to assess idiom knowledge after treatment. Table 2 presents the descriptive statistics for the posttest scores.

Table 2. Descriptive Statistics of Posttest for Idiom Knowledge

Group	N	Mean	Std. Deviation	Minimum	Maximum
Experimental Group 1 (AI + Etymology)	20	36.10	2.65	32.00	40.00
Experimental Group 2 (Etymology Only)	20	31.25	2.78	27.00	36.00
Control Group	20	27.40	2.92	23.00	32.00

As shown in Table 2, the posttest scores reveal notable differences across groups. Experimental Group 1 (AI + Etymology) achieved the highest mean score ($M = 36.10$, $SD = 2.65$), followed by Experimental Group 2 (Etymology Only) ($M = 31.25$, $SD = 2.78$), and the Control Group ($M = 27.40$, $SD = 2.92$). The higher mean score in Experimental Group 1 suggests that the integration of AI-based tools with etymological elaboration was associated with superior idiom learning outcomes compared to etymological elaboration alone or traditional instruction. The standard deviations indicate moderate variability within each group, with the Control Group showing slightly greater dispersion. To determine whether the observed differences in posttest scores were statistically significant, a one-way ANOVA was conducted with group as the independent variable and posttest scores as the dependent variable. Prior to the ANOVA, normality was confirmed using Shapiro-Wilk tests ($p > 0.05$ for all groups), and homogeneity of variances was verified via Levene's test ($F(2, 57) = 0.892$, $p = 0.416 > 0.05$). Table 3 presents the ANOVA results.

Table 3. One-Way ANOVA for Posttest Idiom Knowledge Scores

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	618.342	2	309.171	39.875	0.000
Within Groups	442.050	57	7.755		
Total	1060.392	59			

The ANOVA results ($F(2, 57) = 39.875$, $p < 0.05$) indicate a statistically significant difference in posttest idiom knowledge scores across the three groups. The large F-value and significant p-value suggest that the instructional methods had a substantial impact on idiom learning outcomes. To further explore these differences, post-hoc comparisons were conducted. Tukey's HSD test was used to identify specific group differences in posttest scores, as it controls for Type I error in multiple comparisons. Table 4 presents the results of the post-hoc analysis.

Table 4. Tukey HSD Post-Hoc Comparisons for Posttest Idiom Knowledge Scores

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval
					Lower Bound
Experimental Group 1 (AI + Etymology)	Experimental Group 2 (Etymology Only)	4.85	0.880	0.000	2.77
Experimental Group 1 (AI + Etymology)	Control Group	8.70	0.880	0.000	6.62
Experimental Group 2 (Etymology Only)	Control Group	3.85	0.880	0.000	1.77

The post-hoc comparisons, conducted using Tukey's HSD test, revealed significant differences in posttest idiom knowledge scores across all group pairs ($p < 0.05$), highlighting the distinct impacts of the instructional methods. The results demonstrate that etymological elaboration integrated with AI-based instruction (Experimental Group 1) significantly outperformed both etymological elaboration without AI (Experimental Group 2) and traditional instruction (Control Group) in enhancing idiom knowledge among upper-intermediate Iranian EFL learners. Experimental Group 2 also outperformed the Control Group, confirming the efficacy of etymological elaboration even without AI support. These findings highlight the synergistic potential

of AI-driven tools and etymological elaboration in improving idiom learning outcomes, with significant implications for EFL pedagogy.

Discussion and Conclusion

The purpose of this study was to evaluate the effectiveness of integrating etymological elaboration with AI-based instruction on the idiom learning of upper-intermediate Iranian EFL learners. The results revealed that learners in the AI + Etymology group significantly outperformed both those who received only etymological elaboration and those instructed through traditional memorization. These findings point to a synergistic effect between cognitively grounded strategies and adaptive technological affordances, with clear implications for second language pedagogy.

The superior performance of the AI + Etymology group is consistent with the principles of Dual Coding Theory, which emphasizes the integration of verbal and non-verbal information to enhance memory (4). By presenting idioms alongside etymological narratives and AI-generated visualizations, learners processed idiomatic expressions through both linguistic and imagistic channels, thereby strengthening recall and production. This outcome is supported by prior research demonstrating that etymological elaboration enhances idiom retention through cognitive elaboration (5-7). In this study, AI-based platforms amplified these effects by generating adaptive feedback, contextualized practice, and mnemonic aids—pedagogical features that align with advances in intelligent tutoring systems (13).

The significant gains observed in the AI + Etymology group also align with studies highlighting the potential of AI in reshaping language education. AI-driven tools offer personalized instruction and interactive learning environments that go beyond static input (18). Through natural language processing and adaptive learning algorithms, these tools tailor instruction to learners' needs, facilitating engagement and autonomy (16, 17). The present study demonstrates that when combined with etymological elaboration, AI-based platforms not only provide individualized pathways but also contextualize idioms within interactive cultural narratives, thereby addressing both cognitive and cultural dimensions of figurative language learning.

Importantly, the findings also revealed that the Etymology Only group significantly outperformed the Control Group. This confirms the pedagogical value of etymological elaboration in isolation, reinforcing evidence that tracing idioms back to their historical or cultural origins enhances learners' figurative competence (12, 24). Studies in both Iranian and Croatian contexts show that etymological explanations lead to deeper processing and improved retention compared to rote learning (6, 25). Such results suggest that the historical and cultural grounding of idioms serves as a cognitive scaffold, enabling learners to develop vivid mental associations that support both recognition and productive use.

In contrast, the Control Group's comparatively lower performance highlights the limitations of traditional idiom instruction based on rote memorization. This aligns with critiques that conventional approaches, often limited to dictionary definitions and decontextualized drills, fail to address the figurative and cultural aspects of idioms (2, 3). While some earlier research suggested minimal differences between literal and etymological approaches (8), the present study reinforces the argument that deeper, cognitively informed strategies are more effective, particularly when coupled with adaptive technologies.

The results also resonate with cross-linguistic research that underscores the role of transparency and cultural familiarity in idiom acquisition. Learners often attempt to transfer idioms from their first language, with varying success (9). In this study, the integration of etymological elaboration and AI tools helped mitigate potential misinterpretations by contextualizing idioms within culturally authentic narratives. This aligns with findings that context-rich exposure enhances idiomatic competence by embedding idioms within cultural frameworks (10, 11). Thus, AI not only facilitated memory and engagement but also mediated cultural understanding, an essential component of idiomatic learning.

Another dimension of this study's findings relates to learner motivation. Motivation has long been recognized as a central factor in second language acquisition (26). By combining interactive AI-driven tasks with engaging etymological narratives, the AI + Etymology approach likely enhanced learners' intrinsic motivation to explore figurative language. Prior research demonstrates that learners are more engaged when instruction is multimodal and interactive, as opposed to static or decontextualized (19, 20). The present findings confirm that technology-mediated approaches can sustain learners' attention and foster deeper investment in idiom learning, an area traditionally viewed as tedious or overly advanced (23).

Furthermore, the study's contribution extends to broader debates in applied linguistics about methodological rigor and replicability. Reviews of idiom research highlight the need for diverse and systematic methodologies to validate findings (1). By employing a quasi-experimental design with control and experimental groups, this study responds to calls for more robust designs in idiom research, providing empirical evidence for the effectiveness of AI-enhanced etymological elaboration. It also contributes to the growing literature on replication, suggesting that results from earlier cognitive-linguistic studies can be extended and even magnified through technological integration (23).

At the same time, the findings must be contextualized within the evolving landscape of AI in education. While AI offers adaptive, data-driven learning pathways, its integration into language pedagogy raises challenges related to digital literacy, infrastructure, and teacher readiness (22, 32). This study demonstrates that when appropriately scaffolded, AI tools can enrich idiom instruction, but their effectiveness depends on careful design and contextual sensitivity. The positive outcomes observed here underscore the need for balancing technological innovation with pedagogical depth, ensuring that AI complements rather than replaces the human, cultural, and contextual elements of language teaching (14, 33).

The study also sheds light on the evolving role of idioms in L2 pedagogy. For decades, idioms were marginalized in curricula due to their perceived difficulty (34, 35). However, increasing evidence underscores their importance in fostering communicative competence, pragmatic fluency, and cultural literacy (2, 12). The current findings reinforce the argument that idioms should not be relegated to incidental exposure but systematically integrated into language instruction, especially when supported by cognitively grounded strategies and technological mediation.

Overall, the results demonstrate that AI-enhanced etymological elaboration provides a powerful framework for idiom instruction, one that addresses the cognitive, motivational, cultural, and technological dimensions of learning. By situating idioms within historical narratives and coupling them with adaptive practice, this approach enables learners not only to recall idioms more effectively but also to deploy them with greater cultural and pragmatic awareness. This aligns with contemporary calls for integrated pedagogies that blend cognitive and digital literacies (15, 21).

Despite its promising findings, this study is subject to several limitations. First, the sample size was limited to 60 Iranian upper-intermediate EFL learners, which may restrict the generalizability of results to other cultural or proficiency contexts. Larger and more diverse populations would allow for stronger external validity. Second, the study focused on a relatively short intervention period of six weeks, which may not capture the long-term effects of AI-enhanced etymological elaboration on idiom retention and transfer. Longitudinal research is necessary to determine whether these gains persist over time. Third, while the study employed AI tools designed to deliver adaptive feedback and mnemonic aids, it did not isolate the specific AI features (e.g., chatbots, gamification, or adaptive algorithms) responsible for the observed improvements. A more fine-grained analysis would clarify which technological affordances most effectively complement etymological elaboration. Finally, the study did not assess learner attitudes toward the intervention in detail. While performance gains were evident, qualitative insights into learner perceptions and experiences could provide a more holistic understanding of the pedagogical impact.

Future research should explore the scalability of AI-enhanced etymological elaboration across different proficiency levels and cultural backgrounds. Comparative studies involving beginner and advanced learners, as well as learners from diverse

linguistic backgrounds, would help assess whether the approach is universally applicable or more effective for specific populations. Additionally, research should examine the long-term retention of idioms acquired through AI-based etymological elaboration, ideally through delayed post-tests conducted months after instruction. Future studies could also focus on identifying the most impactful AI features for idiom learning, such as adaptive sequencing, interactive storytelling, or embodied conversational agents. Mixed-method designs combining quantitative assessments with qualitative interviews or think-aloud protocols would further illuminate how learners engage with idioms in AI-enhanced environments. Finally, research should investigate how teacher training and digital literacy development can facilitate the integration of AI tools into idiom instruction, ensuring that educators are equipped to implement these innovations effectively.

The findings of this study carry significant pedagogical implications. Teachers should consider systematically integrating idiom instruction into curricula, using etymological elaboration to provide learners with historical and cultural grounding. Incorporating AI-based tools can further enhance this process by offering adaptive feedback, engaging visualizations, and interactive practice that cater to individual learner needs. Curriculum designers are encouraged to develop materials that combine cognitive linguistic approaches with technological affordances, ensuring that idioms are taught not as isolated lexical items but as culturally embedded expressions. Additionally, policymakers and educational institutions should invest in digital infrastructure and teacher training programs to facilitate the adoption of AI-enhanced idiom instruction. By doing so, they can foster both linguistic and digital literacies, preparing learners for the demands of global communication in the 21st century.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adhered in conducting and writing this article.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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