

Received: 29 June, 2026

Accepted: 21 September, 2026

Published: 30 September, 2026

A Structural Model of Artificial Intelligence Integration in Language Instruction: A Systematic Review of Mediating Pathways to Written English Proficiency Among EFL Learners

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Cite this article:

K. A. H. Albataineh, A. J. A. Tajuddin, and R. Romly (2026). A Structural Model of Artificial Intelligence Integration in Language Instruction: A Systematic Review of Mediating Pathways to Written English Proficiency Among EFL Learners. *Revista Cultura Científica*, (24) pp. 1606–1617 <https://doi.org/10.70517/revcc2624132>

Abstract

Background: Generative artificial intelligence (AI) is reshaping English-as-a-foreign-language (EFL) writing instruction, yet the mechanisms through which AI integration may improve written English proficiency (WEP) remain theoretically fragmented.

Objective: This systematic review synthesises literature published within the 2018–2026 review window, together with foundational theoretical works, to develop a structural-equation-modelling (SEM) framework in which self-regulated learning (SRL), learner engagement, self-efficacy, and AI literacy operate as parallel and serial mediators between AI integration and WEP.

Method: Following a structured thematic-synthesis approach, the reviewed literature was organised around four connected domains: AI-supported writing instruction, generative-AI adoption, learner and teacher perceptions, and self-regulated learning in AI-supported contexts. The

synthesis then examined evidence for direct, mediating, and serial relationships among the focal constructs.

Key findings: The literature provides partial support for the individual links connecting AI integration, the proposed mediators, and language-learning outcomes; however, these pathways are rarely tested within a single integrated model. Evidence for mediation remains fragmented, the proposed serial chain is largely untested, and Jordanian and broader Levantine contexts remain under-represented relative to East Asian and Gulf settings.

Implications: The review proposes fourteen hypotheses: nine direct-effect hypotheses (H1–H9) and five mediation hypotheses (H10a–H10e), including one serial mediation chain, as a framework for future quantitative validation among English majors at public Jordanian universities.

Keywords: artificial intelligence, generative AI, self-regulated learning, EFL, English writing, structural model

1. INTRODUCTION

The rapid spread of generative artificial intelligence (AI) tools, including ChatGPT, Grammarly, and other large language models (LLMs), has transformed the teaching and learning of English-as-a-foreign-language (EFL) writing in higher education. What initially appeared mainly as occasional automated support for feedback, correction, and revision has developed into a substantial body of empirical research examining the effects of generative AI on students' writing processes, motivation, engagement, and language-learning outcomes [1, 2]. Recent reviews indicate that the field is moving from exploratory descriptions of AI use toward more theoretically informed and methodologically rigorous investigations. Nevertheless, the mechanisms through which AI integration may contribute to written English proficiency (WEP) remain insufficiently integrated across studies.

Existing research has separately examined psychological and behavioural constructs such as self-regulated learning (SRL), learner engagement, self-efficacy, and AI literacy. These constructs are frequently associated with the adoption, use, and outcomes of AI-supported learning, but they are typically analysed in isolation, in pairs, or within limited mediation models. Consequently, the literature does not yet provide a coherent structural account of how these mechanisms may operate jointly or sequentially to influence WEP. This limitation is particularly important because AI integration should not be treated as an inherently beneficial intervention: the educational value of AI depends on how learners regulate its use, engage with feedback, develop confidence, and acquire the literacy needed to evaluate and use AI output critically.

The need for an integrated model is especially pertinent in Jordanian higher education. The use of generative AI by undergraduate English majors is increasing, yet quantitative evidence linking AI integration to written English outcomes through clearly specified psychological mechanisms remains scarce. The Jordan-specific study identified in the reviewed literature by Al-Smadi et al. [3] provides qualitative evidence concerning accessibility, adaptive feedback, changing learning habits, technological proficiency, and social dynamics in AI-supported self-regulated learning. However, its qualitative design does not establish structural or mediating relationships between AI use and WEP. This creates a clear need for a model that can be quantitatively evaluated in Jordanian public universities while remaining grounded in the broader international literature.

Accordingly, this review has three objectives. First, it synthesises empirical and theoretical literature on AI integration in EFL writing instruction within the 2018–2026 review window, with particular attention to studies using structural equation modelling (SEM), partial least squares SEM (PLS-SEM), experimental designs, and other approaches capable of informing directional relationships among constructs. Second, it identifies evidence for direct, mediating, and serial-mediating relationships among AI integration, SRL, learner engagement, self-efficacy, AI literacy, and WEP. Third, it consolidates these relationships into a coherent structural framework comprising nine direct-effect hypotheses (H1–H9) and five mediation hypotheses (H10a–H10e), including a serial mediation chain proposed for future quantitative validation.

The contribution of the review is both theoretical and practical. Theoretically, it moves beyond single-mediator and bivariate explanations by organising fragmented findings within one multi-mediator structure. Practically, it provides EFL writing instructors, curriculum designers, and researchers with a framework for examining whether access to AI tools produces better writing outcomes directly or whether such outcomes depend on the development of self-regulation, engagement, self-efficacy, and AI literacy. Rather than assuming a uniformly positive effect of AI integration, the proposed framework treats these learner processes as potentially decisive mechanisms linking technological access to measurable written proficiency.

2. REVIEW METHODOLOGY

The study was designed as a structured systematic synthesis for theory building rather than as a meta-analysis. The review considered literature within the stated 2018–2026 period and retained foundational theoretical works published earlier where they were necessary to support the conceptual framework. The contemporary evidence base comprised empirical studies, systematic and scoping reviews, bibliometric analyses, and theoretically relevant investigations addressing generative AI, automated writing support, AI adoption, EFL learning, learner engagement, self-efficacy, AI literacy, SRL, and writing-related outcomes. The review was centred on literature indexed in the Web of Science Core Collection, as reported in the source study, while the conceptual interpretation was informed by established theories used in technology adoption, self-regulated learning, sociocultural learning, and educational ecology.

For synthesis, the literature was organised into four connected domains: (i) AI-supported writing instruction and feedback; (ii) generative-AI adoption and acceptance; (iii) learner and teacher perceptions, including ethical and dependency concerns; and (iv) SRL and related motivational or behavioural mechanisms in AI-supported environments. The evidence was then examined for relationships relevant to six focal constructs: AI integration, SRL, learner engagement, self-efficacy, AI literacy, and WEP. Particular attention was given to studies using SEM, PLS-SEM, latent-growth modelling, experimental or quasi-experimental designs, and mediation analysis because these approaches provide the strongest basis in the reviewed literature for formulating directional and indirect pathways.

The synthesis was interpretive rather than effect-size based. Consequently, the review does not pool effect sizes or claim that the proposed causal pathways have already been established. Instead, it identifies converging and contradictory findings, distinguishes direct evidence from indirect support, and uses that evidence to formulate hypotheses for subsequent empirical testing. This distinction is important because several recent reviews document rapid growth in generative-AI research while also noting fragmentation in theoretical grounding, design, and outcome measurement [4–6]. Bibliometric evidence similarly shows strong geographic concentration and uneven representation across regions [7, 8]. The present review therefore uses the literature to construct a testable model rather than to present the model itself as a validated causal explanation.

3. LITERATURE SYNTHESIS

3.1. AI-SUPPORTED WRITING, FEEDBACK, AND ADOPTION

A substantial body of recent research has examined the role of AI-generated feedback in EFL and ESL writing. Boudouaia et al. [9] investigated the integration of AI-generated content feedback over a ten-week intervention and reported improvements in aspects of syntactic and lexical complexity, although effects on accuracy and fluency were more variable. Their findings illustrate an important pattern across the literature: AI can support specific dimensions of writing development, but the magnitude and consistency of the gains depend on the target feature, the feedback design, and the instructional context.

Chan et al. [10] used a large randomised controlled design to examine generative-AI feedback in university-level English writing and reported improvements in essay revision performance together with measurable differences in learners' engagement and emotional responses. This study is particularly relevant because it links feedback use to both proficiency-related outcomes and learner processes. The present review relies on this non-retracted study and excludes a later overlapping publication by the same authors that was subsequently retracted. Algaraady and Mahyoob [11] similarly examined ChatGPT's capacity to identify and analyse EFL writing errors. Their findings suggest that AI can perform competitively for common surface-level errors while human teachers remain important for more complex, context-sensitive judgements.

Automated writing evaluation and classroom-based AI use extend this picture. Alshehri [12] reported generally positive Saudi EFL learner evaluations of personalised automated feedback while also identifying concerns about feedback depth and over-reliance. Maulidiyah [13] found that students used AI during pre-writing mainly for idea generation and language improvement rather than as a substitute for complete content development. Jaramillo et al. [14] showed that combining a structured writing-workshop model with AI tools such as Grammarly and ChatGPT could support coherence, organisation, and writing confidence. These studies collectively indicate that AI-supported writing is more effective when it is embedded within explicit pedagogy rather than treated as an autonomous replacement for instruction.

Higher-order syntheses reinforce this interpretation. Xiao et al. [15] describe ChatGPT as both a scaffold for the EFL writing process and a source of pedagogical tension concerning authorship and originality. Liu et al. [16] likewise show that generative AI can support critical engagement when its affordances are deliberately aligned with genre-based pedagogy. Across this literature, the strongest and most consistent benefits tend to concern feedback access, lexical and syntactic support, surface-level error correction, planning, and revision. Effects on higher-order features such as argumentation, coherence, fluency, authorship, and critical judgement are more context dependent. This pattern supports the plausibility of a direct path from AI integration to WEP while simultaneously suggesting that the direct effect alone is unlikely to explain the full range of outcomes.

A related literature examines why learners and teachers adopt generative AI. Much of this work draws on the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), or extended versions of these frameworks. Among Saudi EFL learners, Alotaibi et al. [17] found that perceived usefulness exerted a stronger influence on attitudes toward ChatGPT adoption than perceived ease of use. Ma [18] showed that personal innovativeness, subjective norms, and trust also contributed to generative-AI acceptance among Chinese EFL postgraduates. Khoso et al. [19] demonstrated that digital literacy influences perceptions of ease of use and usefulness and that these perceptions contribute to trust, attitudes, behavioural intentions, and creativity-related outcomes.

Teacher-side adoption research provides a complementary perspective. Parviz and Arthur [20] modelled Iranian EFL teachers' behavioural intentions to integrate generative AI using PLS-SEM and fuzzy-set qualitative comparative analysis, incorporating AI-related TPACK variables alongside UTAUT constructs. Their complex structural model demonstrates the methodological maturity of adoption research while simultaneously highlighting how rarely comparable structural sophistication is applied to learner-side writing proficiency. Ashoori Tootkaboni and Maghsoudi [21] extended TAM for pre-service teachers by incorporating AI anxiety, AI self-efficacy, AI literacy, and AI readiness, and found self-efficacy and literacy to be important proximal predictors of adoption intention.

Evidence from under-represented contexts further indicates that adoption is shaped by institutional and cultural con-

ditions. Braha [22] identified infrastructural and institutional barriers among Kosovan EFL students despite generally favourable attitudes toward AI-assisted language learning. Alharbi [23] documented a mismatch between teachers' awareness of students' AI use and the actual prevalence of that use, with implications for assessment validity and academic integrity. Kanont et al. [24] found perceived benefits and attitudes toward technology to be important predictors of generative-AI adoption among higher-education students. Together, these studies support the plausibility of relationships between AI integration and the proposed learner-side mediators, but they also show that adoption and educational benefit are not equivalent constructs.

3.2. LEARNER, TEACHER, AND SELF-REGULATORY FACTORS

Learner and teacher perceptions provide further evidence that the educational effects of AI depend on psychological and pedagogical processes. Altamimi [25] and Alhamam [26] report that Saudi EFL learners value rapid and personalised AI assistance while also expressing concern that excessive reliance may weaken independent writing and encourage superficial processing of feedback. Farneste and Bicjutko [27] found differences between school and university students in the sophistication and self-directedness of AI use, suggesting that educational level and learner autonomy should be considered when operationalising AI integration.

Ethical and dependency concerns complicate any assumption that more AI use automatically leads to better learning. Alreshidi et al. [28] found generally positive perceptions of AI's contribution to English learning among Lebanese university students alongside concerns about academic integrity and the possible weakening of independent critical thinking. Khoso et al. [29] reported that AI-related factors, including dependency-related experiences, were associated with higher fear of missing out (FoMO), while FoMO was negatively related to reading comprehension. These results show that AI-supported learning can generate adverse psychological pathways as well as beneficial ones. Albeih and Rice [30] add a sociolinguistic concern: large language models may reproduce dominant standard-English hierarchies and therefore raise questions about linguistic diversity, representation, and equity.

Teacher perceptions similarly foreground the need for pedagogical adaptation. Asad et al. [31] describe ChatGPT as a generative tool with substantial potential for individualised learning and expanded feedback, but they also identify challenges involving assessment design, originality, and changing conceptions of authorship. Kushki et al. [32] show that pre-service teachers' AI literacy is central to responsible use with English-language learners. Kohnke et al. [33] likewise demonstrate the value of structured professional development through a microlearning intervention addressing generative AI, TPACK, and self-regulated learning. These studies strengthen the case for treating AI literacy not simply as a technical skill but as a pedagogical, evaluative, and ethical capacity.

Among the proposed mediators, SRL is especially important because AI-supported writing requires learners to plan, monitor, evaluate, and revise their work while deciding when AI assistance is appropriate. Al-Smadi et al. [3] identified five themes in Jordanian EFL learners' engagement with AI-supported SRL: accessibility and inclusivity, adaptive feedback, changes in learning habits, technological proficiency, and social dynamics. The study offers contextually valuable evidence but does not test directional or mediating relationships, leaving the AI integration–SRL–WEP pathway open for quantitative investigation.

Evidence from other contexts provides partial support for this pathway. Shi et al. [34] used latent-growth modelling to track the co-development of SRL and task engagement among Chinese secondary EFL students in AI-assisted classrooms and found statistically significant development in both constructs together with a positive relationship between their trajectories. This finding is directly relevant to the proposed serial relationship from SRL to engagement. Lai [35] reported that AI-assisted blended writing improved writing self-efficacy and resilience, whereas conventional instruction showed a comparative advantage for aspects of SRL and metacognitive development. The result is important because it demonstrates that AI use does not automatically strengthen self-regulation; pedagogical scaffolding remains necessary. Chen and Alibakhshi [36], using a class-randomised design, found that AI-powered applications improved cognitive, metacognitive, and resource-management strategies together with language achievement, providing stronger experimental support for a pathway linking AI integration, self-regulatory processes, and achievement.

Several recent studies use structural models to investigate adjacent motivational and self-regulatory mechanisms. Zheng [37] used SEM to examine self-efficacy, AI literacy, and engagement in AI-driven EFL settings. Zhang et al. [38] found that AI-learning self-efficacy and foreign-language classroom anxiety mediated relationships involving AI literacy and willingness to communicate. Liu and Fan [39], using a Stimulus–Organism–Response framework, showed that AI literacy and foreign-language enjoyment mediated the effects of teacher and technical support on willingness to communicate. Wang and Zou [40] modelled L2 writing-feedback engagement in a ChatGPT-mediated environment as a function of teacher support, motivation, and emotion. Suciati et al. [41] combined SEM and ANCOVA in a quasi-experimental study and reported improvements in self-efficacy, writing performance, and engagement through AI-chatbot-enhanced flipped learning. Wu and Li [42] further showed that achievement emotions can mediate the relationship between perceived support and engagement in multimodal generative-AI chatbot learning.

Taken together, these studies provide partial empirical support for the individual components of the proposed model. However, the evidence is distributed across different outcomes, populations, tools, and theoretical frameworks. No single study identified in the reviewed literature simultaneously estimates all four proposed mediators between AI integration and WEP, and evidence for the complete serial sequence SRL → engagement → self-efficacy → AI literacy remains especially limited. The purpose of the proposed model is therefore not to claim that this sequence has been established, but to translate fragmented evidence into a set of explicit, falsifiable hypotheses.

3.3. STRUCTURAL EVIDENCE AND RESEARCH GAPS

Systematic, scoping, and bibliometric reviews provide higher-order support for the conclusion that the field is expanding rapidly but remains structurally fragmented. Li et al. [1] document substantial growth in empirical generative-AI research in language learning and teaching and note a transition toward more rigorous study designs. Wang et al. [2] similarly identify increasing methodological sophistication but uneven theoretical integration. Lee et al. [4] report that higher education dominates classroom-based generative-AI language research, while Raitskaya and Tikhonova [5] and Noroozi et al. [6] call for stronger theoretical and methodological integration in generative-AI research.

Four interrelated research gaps emerge from this synthesis:

1. **Absence of an integrated multi-mediator structural model.** Existing SEM and PLS-SEM studies tend to test bivariate, triadic, or domain-specific relationships. Studies such as Zheng [37], Zhang et al. [38], Liu and Fan [39], and Suciati et al. [41] provide important structural evidence, but none estimates the complete parallel-and-serial model proposed here.
2. **Limited direct evidence for AI-supported SRL as a mediator of WEP.** The strongest evidence is experimental, developmental, or correlational rather than a direct mediation test. Chen and Alibakhshi [36] and Shi et al. [34] support relationships among AI use, self-regulatory processes, engagement, and achievement, whereas the Jordanian evidence remains qualitative [3].
3. **Geographic imbalance and limited Jordanian evidence.** Bibliometric studies show that contributions are concentrated in a relatively small number of countries and regions [7, 8]. The reviewed corpus contains very limited Jordan-specific evidence and no identified quantitative study that tests the proposed full structural relationship between AI integration and WEP among English-major undergraduates in Jordanian public universities.
4. **Fragmented operationalisation of written English proficiency.** Across studies, writing-related outcomes are represented by essay-revision scores, error detection, writing performance, self-efficacy, language achievement, or other proxies. This heterogeneity reduces direct comparability and underscores the need for a clearly specified, multidimensional measure of WEP in future empirical validation.

These gaps justify the development of a model that is explicit about both direct and indirect relationships. The proposed framework is therefore a theory-building synthesis: it consolidates evidence that is individually plausible but not yet jointly tested, thereby defining a research agenda rather than presenting a confirmed causal structure.

4. CONCEPTUAL FRAMEWORK

4.1. THEORETICAL FOUNDATION

The proposed model draws on several complementary theories and frameworks because no single perspective fully explains the pathway from technological integration to written proficiency. The Technology Acceptance Model (TAM) [43] and the Theory of Planned Behavior (TPB) [44] provide a basis for understanding how perceptions, attitudes, intentions, and beliefs shape engagement with AI-supported learning. In the contemporary adoption literature, perceived usefulness, ease of use, trust, innovativeness, self-efficacy, and AI literacy repeatedly appear as proximal factors influencing acceptance and behavioural intention [17–19, 21]. These relationships support the inclusion of learner engagement, self-efficacy, and AI literacy as mechanisms that may connect AI integration with educational outcomes.

Self-Regulated Learning Theory [45] provides the primary theoretical basis for H1 and H6. SRL conceptualises learning as a cyclical process involving forethought, performance, self-monitoring, and self-reflection. AI-supported writing tools can potentially intervene at each stage by assisting planning, generating feedback, prompting revision, or providing explanations. However, the mixed evidence reported by Shi et al. [34], Lai [35], and Chen and Alibakhshi [36] indicates that access to AI does not automatically produce stronger SRL; the quality of instructional design and learner regulation remains important.

Sociocultural Theory [46], particularly the concept of the zone of proximal development, supports the interpretation of AI as a possible dialogic scaffold rather than merely an automated answer generator. Wang and Stojković [47] describe

AI meta-prompting as cognitive scaffolding in writing instruction, illustrating how carefully designed interaction with AI can extend learners' reasoning and revision processes. This perspective is complemented by the TPACK framework reflected in recent teacher-education studies [32, 33], which emphasises that effective technological integration depends on the interaction of technological, pedagogical, and content knowledge.

Finally, Bronfenbrenner's Ecological Systems Theory [48] situates the model within wider institutional, cultural, and policy environments. AI integration occurs within nested systems that include classroom practices, assessment rules, university policies, technological infrastructure, social expectations, and national educational priorities. For the proposed application in Jordanian public higher education, this ecological perspective is important because structural relationships identified elsewhere may vary according to local institutional support, learner access, language-learning traditions, and academic-integrity policies.

4.2. PROPOSED STRUCTURAL MODEL AND HYPOTHESES

Synthesising the theoretical foundations with the empirical patterns identified above produces a structural model in which AI integration in language instruction is the exogenous construct; SRL, learner engagement, self-efficacy, and AI literacy are the proposed mediating constructs; and WEP is the endogenous outcome. The framework includes direct effects from AI integration to each mediator and to WEP, direct effects from each mediator to WEP, four parallel indirect pathways, and one proposed serial pathway. The resulting structure is presented in Figure 1. The figure should be interpreted as a hypothesis-generating representation of relationships requiring empirical validation rather than as evidence that these relationships have already been causally established.

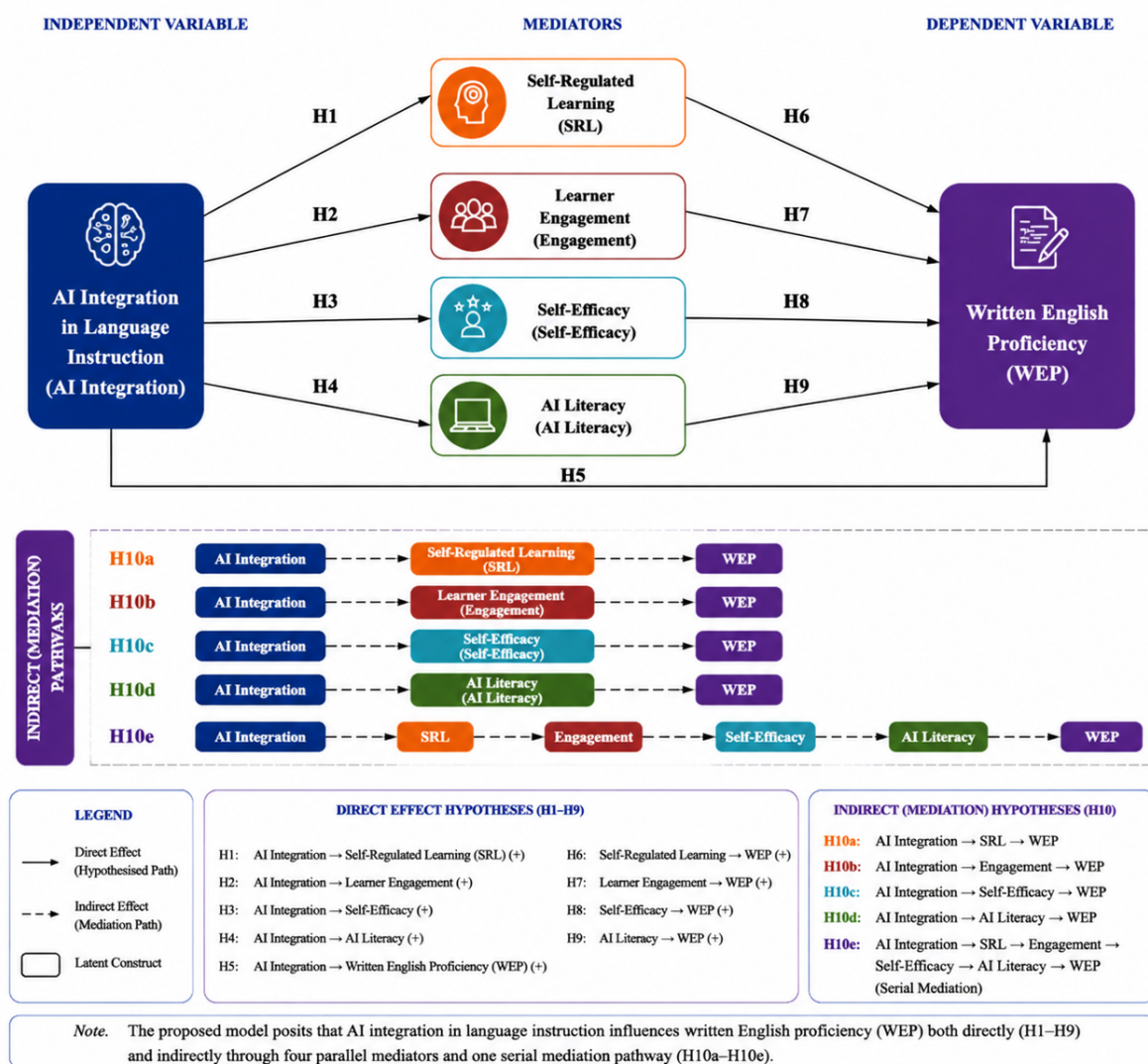


Figure 1. Proposed structural model of AI integration in EFL writing instruction

Consistent with Figure 1, the following hypotheses are proposed for future quantitative validation.

Direct effects.

- H1:** AI integration is positively associated with self-regulated learning.
- H2:** AI integration is positively associated with learner engagement.
- H3:** AI integration is positively associated with self-efficacy.
- H4:** AI integration is positively associated with AI literacy.
- H5:** AI integration is positively associated with written English proficiency.
- H6:** Self-regulated learning is positively associated with written English proficiency.
- H7:** Learner engagement is positively associated with written English proficiency.
- H8:** Self-efficacy is positively associated with written English proficiency.
- H9:** AI literacy is positively associated with written English proficiency.

Parallel mediation.

- H10a:** Self-regulated learning mediates the relationship between AI integration and written English proficiency.
- H10b:** Learner engagement mediates the relationship between AI integration and written English proficiency.
- H10c:** Self-efficacy mediates the relationship between AI integration and written English proficiency.
- H10d:** AI literacy mediates the relationship between AI integration and written English proficiency.

Serial mediation.

H10e: AI integration influences written English proficiency through a serial mediation chain in which self-regulated learning predicts learner engagement, learner engagement predicts self-efficacy, self-efficacy predicts AI literacy, and AI literacy in turn predicts written English proficiency.

H1–H5 specify direct paths from AI integration, H6–H9 specify direct paths from the four proposed mediators to WEP, H10a–H10d specify four parallel single-mediator pathways, and H10e specifies the proposed serial pathway. No moderating variables are included in the present framework. This restriction is deliberate: contextual factors are acknowledged theoretically, but the model is kept as a mediation-focused structure that can be tested and subsequently extended if empirical evidence supports the need for moderation.

5. DISCUSSION

5.1. INTERPRETATION OF THE STRUCTURAL SYNTHESIS

The literature points to a central tension. Individual components of the proposed model are supported by empirical evidence, but the model as a whole has not yet been tested. Adoption studies support relationships involving usefulness, trust, self-efficacy, literacy, and behavioural engagement [17–19]. Writing-instruction studies show that AI-generated feedback can improve selected dimensions of writing performance, particularly when it is combined with pedagogical scaffolding [9, 10, 14]. SRL and engagement studies provide evidence that self-regulation, engagement, self-efficacy, and AI literacy are meaningfully related in AI-supported learning environments [34, 37, 41]. The missing element is a single study that estimates the full set of direct and indirect pathways with WEP as the clearly operationalised outcome.

The proposed framework should therefore be viewed as an integrative hypothesis model rather than a summary of already established causal effects. This distinction is especially important for H10e. The serial sequence from SRL through engagement and self-efficacy to AI literacy is theoretically plausible and partly supported by separate studies, but the complete chain has not been directly demonstrated in the reviewed evidence. Future empirical work should compare the proposed serial model with plausible alternatives, examine discriminant validity among closely related constructs, and determine whether the ordering of the mediators is supported by data rather than assumed from conceptual proximity.

The literature also contains findings that resist a simple positive account of AI integration. Khoso et al. [29] show that AI-related experiences can be associated with increased FoMO, which in turn is negatively related to reading comprehension. Lai [35] found stronger writing self-efficacy and resilience in AI-assisted blended learning while conventional instruction showed advantages for aspects of self-regulation and metacognitive development. Such findings suggest that AI can support some learner outcomes while simultaneously creating dependency, cognitive offloading, anxiety, or reduced self-regulatory effort. The magnitude and even direction of relationships may therefore differ across populations, instructional designs, task types, and levels of AI literacy.

Geographic context is another important source of uncertainty. Much of the structural and experimental evidence comes from East Asian, Gulf, and other non-Jordanian settings [7, 8]. The Jordanian evidence identified in this review is valuable but remains limited in design and scope [3]. Empirical validation in Jordan should therefore avoid assuming measurement equivalence across contexts. Constructs such as engagement, AI literacy, self-efficacy, and ethical AI use may be shaped by local assessment practices, institutional policies, language backgrounds, and access conditions.

5.2. PEDAGOGICAL AND ETHICAL IMPLICATIONS

The synthesis suggests several implications for EFL writing instruction. First, AI-generated feedback appears particularly useful for lower-order and procedural writing tasks such as identifying surface errors, supporting vocabulary

and sentence-level revision, and providing rapid iterative feedback [9, 11]. Higher-order writing processes—including argumentation, coherence, rhetorical judgement, source integration, and authorial decision-making—continue to require explicit pedagogy and teacher guidance. AI tools are therefore better positioned as components of a structured feedback ecology than as substitutes for expert instruction.

Second, merely providing access to generative AI is unlikely to produce the self-regulatory benefits assumed by the model. Structured pedagogical design is necessary to help learners decide when to consult AI, how to evaluate its suggestions, how to revise rather than copy, and how to preserve responsibility for the final text. The writing-workshop approach reported by Jaramillo et al. [14] illustrates how AI can be integrated within a broader instructional sequence instead of functioning as an isolated tool.

Third, teacher AI literacy and institutional awareness are essential. The teacher-awareness gap reported by Alharbi [23] indicates that students may adopt AI more rapidly than assessment practices and teacher knowledge evolve. Professional-development research [32, 33] suggests that teachers require not only technical familiarity with generative AI but also pedagogical strategies for task design, feedback, assessment, and academic integrity.

Finally, ethical concerns should be incorporated into the measurement of AI literacy rather than treated as peripheral issues. The reviewed literature identifies risks involving overdependence and reduced independent writing [25, 26], academic integrity [28], and linguistic equity [30]. In the proposed framework, AI literacy should therefore include critical evaluation of output, awareness of limitations and bias, transparent and responsible use, understanding of authorship expectations, and the capacity to decide when AI assistance is inappropriate. A technically competent but uncritical user should not be classified as highly AI-literate in future validation studies.

6. CONCLUSION

This systematic review synthesised empirical and theoretical literature on AI integration in EFL writing instruction to develop a structural framework in which SRL, learner engagement, self-efficacy, and AI literacy are proposed as parallel and serial mediators between AI integration and WEP. The principal theoretical contribution is the consolidation of relationships that have previously been investigated separately across adoption research, AI-supported writing studies, learner-perception research, and SRL-focused investigations. The resulting framework specifies nine direct-effect hypotheses (H1–H9) and five mediation hypotheses (H10a–H10e), including a serial pathway that requires direct empirical testing.

The review also identifies important methodological limitations in the existing literature. WEP is operationalised inconsistently across studies, mediation evidence is distributed across different outcomes and populations, and the complete four-mediator model has not been tested in a single study. Jordanian evidence remains particularly limited, which restricts the extent to which findings from other regions can be assumed to apply directly to English-major students in Jordanian public universities. These limitations provide a clear agenda for future research.

Future studies should validate the proposed framework using PLS-SEM or covariance-based SEM with adequately justified sampling, validated multidimensional measures, and explicit assessment of reliability, convergent validity, discriminant validity, direct effects, indirect effects, and competing structural specifications. Particular attention should be given to H10e because the proposed serial mediation chain is the least directly supported component of the framework. Researchers should also develop a defensible multidimensional operationalisation of WEP that distinguishes actual writing performance from related psychological constructs such as writing self-efficacy. Such work would allow the proposed model to move from an integrative theoretical synthesis to an empirically evaluated explanation of how AI-supported instruction may contribute to written English development.

NOVELTY STATEMENT

To the best of the authors' knowledge, this review is the first to consolidate the fragmented bivariate and triadic relationships identified in the reviewed AI-in-EFL-writing literature into a single SEM-oriented framework that specifies SRL, learner engagement, self-efficacy, and AI literacy as parallel mediators and also proposes a serial pathway linking these constructs to WEP. The novelty lies in the integration and explicit testability of the proposed structure, not in claiming that the complete mediation sequence has already been empirically established. The review further highlights the limited Jordanian evidence base and provides a contextually relevant framework for future quantitative validation among English majors at public Jordanian universities.

ETHICS STATEMENT

Not applicable. This study is a systematic literature review and did not involve human participants, animal subjects, or the collection of primary data.

AUTHORS CONTRIBUTION

All authors contributed to the development of the study, critically reviewed the manuscript, approved the final version, and agreed to be accountable for all aspects of the work.

FUNDING

This research received no external funding.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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