Jiang, B. et al. (Eds.) (2025). Proceedings of the 33rd International Conference on Computers in Education. Asia-Pacific Society for Computers in Education

Designing AI-powered Scaffolds to Foster Metacognition and Agency in EFL Writing

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Abstract: Learners in English as a Foreign Language (EFL) writing often struggle with limited metacognitive strategy use, weak feedback literacy, and insufficient self-regulation. EFL writing requires the coordination of language knowledge, cognitive strategies, and metacognitive skills, which makes these challenges especially significant. While AI writing assistants offer personalized support, most emphasize performance optimization and error correction, which risks reducing learner agency and hindering metacognitive development. This research aims to create an AI-enhanced writing platform designed to foster both writing performance and learner agency. It integrates LLM-based metacognitive prompts, adjustable agency control, and analytics dashboard within a digital writing environment, guided by theories of self-regulated learning, structure and agency, and recursive writing process. Using a Design-Based Research approach, this research involves iterative design, classroom-based pilot studies, and mixed-method evaluation. It has potential contributions include empirical evidence for balanced AI support, theoretical expansion of agency framework into AI-enhanced writing, and practical design principles to enhance learner agency. Preliminary findings and future directions will be discussed in the workshop.

Keywords: Metacognition, self-regulated learning, learner agency, EFL writing, AI assistants, learning analytics

1. Introduction

English as a Foreign Language (EFL) writing requires the integration of cognitive, linguistic, and metacognitive skills, yet learners often struggle with limited metacognitive awareness, weak feedback literacy, and poor self-regulation (Bai & Guo, 2018; Teng & Zhang, 2020). Emerging AI-enhanced writing assistants offer new opportunities to scaffold personalized support and enhance writing practices (Hwang et al., 2023).

However, most AI writing assistants focus primarily on performance optimization and error correction, which can unintentionally limit learners' control over their own writing. Such over-reliance and the offloading of metacognition risks can weaken the development of metacognitive skills such as self-regulation and learner agency in EFL writing (Darvishi et al., 2024; Fan et al., 2025).

Therefore, the key research question in this work is: How can AI be designed to foster student metacognition and agency while enhancing EFL writing performance simultaneously?

2. Research Goal

This research proposes an innovative support platform that leverages AI-driven feedback and analytics to foster learner metacognition and agency in EFL writing. The platform design is grounded in three complementary theoretical frameworks: self-regulated learning (Zimmerman, 2008), the theory of structure and agency (Archer, 2003), and the recursive process model of writing (Tompkins, 1993). This theoretical integration makes the platform go beyond surface-level assistance in the previous research by targeting deeper cognitive and metacognitive dimensions of writing. Specifically, the platform incorporates structured metacognitive prompts, learner control assistance, and learning analytics (LA) dashboard

within existing EFL writing system. This innovative approach enhances both immediate writing performance and long-term metacognitive development, fostering greater learner agency.

3. Proposal of the Support Platform

3.1 Overview of the Support Platform

Figure 1 illustrates the AI-powered EFL writing support platform that integrates metacognitive scaffolding and learner agency control across the entire writing cycle: pre-writing, in-writing, and post-writing. The platform is embedded within an existing Moodle learning management system, ensuring seamless integration into classroom practices in EFL writing.

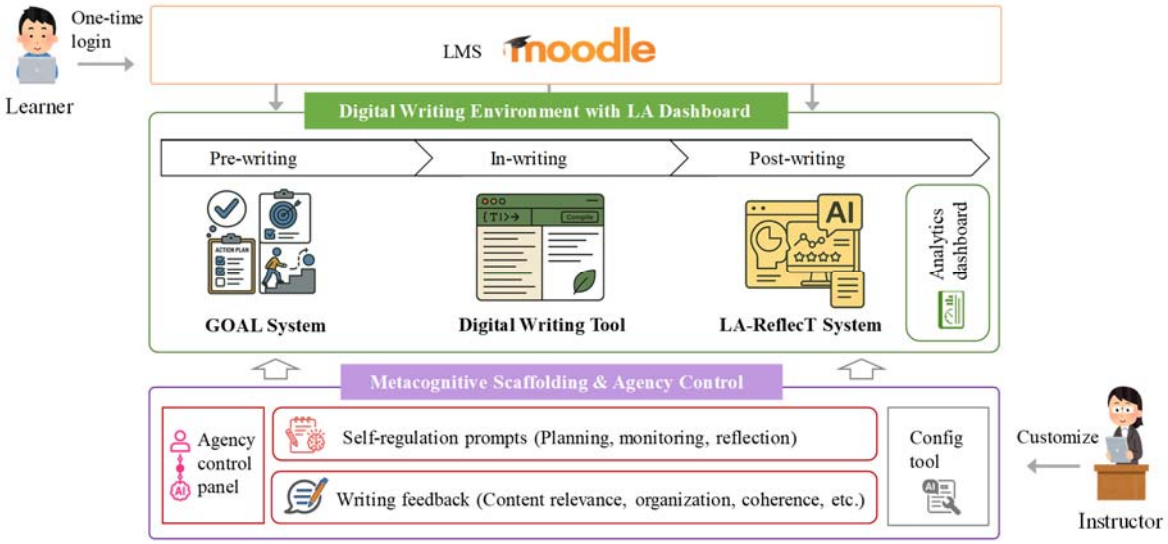

Figure 1. Overview of the proposed platform.

3.2 Digital Writing Environment with Learning Analytics Dashboard

The fundamental learning environment is built on Moodle and consists of three interconnected systems via LTI (Learning Tools Interoperability) that support learners' digital writing:

- GOAL system for pre-writing: A self-directed learning support system that scaffolds planning activities. Learners set academic goals, create writing plans, select tracking indicators, and define writing strategies, initiating the active writing cycle (Li et al., 2021).
- Digital writing tool for in-writing: An Overleaf-based digital tool where students draft, edit, and comment on their texts. This tool supports paragraph construction, iterative revision, and collaborative writing during the writing process.
- LA-ReflecT system for post-writing: A reflection support system that combines multimodal learning analytics with AI-enabled feedback. Learners engage in micro-learning tasks, reflect on their writing tasks, and evaluate their writing performance and processes (Majumdar et al., 2023).
- Analytics dashboard: A LA dashboard visualizes writing frequency, revision behaviors, performance metrics, self-regulation actions, and feedback uptake. Learners use these analytics to revise learning goals, monitor writing behaviors, and reflect on strategy use. Teachers can identify struggling students, monitor class trends, and design tailored instructions.

3.3 Metacognitive Scaffold and Agency Control

This platform introduces a new layer of AI-powered metacognitive scaffold designed to foster self-regulation and learner agency. Its components contain self-regulation prompts, writing feedback engine, and agency control panel:

- Self-regulation prompts: LLM-based prompts are embedded in the digital writing environment through an interactive chat interface. They assist learners to actively engaged in planning, monitoring, and reflection throughout the writing cycle. Specifically, planning prompts encourage learners to set personal goal, make action plans, select task topics, and create outlines in the pre-writing stage; monitoring prompts help students track progress and adjust strategies during writing; reflection prompts help learners evaluate the structure and quality of their texts, identify their strength and weakness, and facilitate strategy reflection in the post-writing stage.
- Writing feedback engine: Learners receive structured AI-generated feedback through an interactive chat interface. Feedback evaluates writing performance across core dimensions, including content relevance, argumentation, organization, coherence, lexical choice and grammatical accuracy. The engine identifies strengths, suggests revision areas and provides concrete example revisions.
- Agency control panel: Learners choose from five adjustable levels of agency control, ranging from metacognition-only, metacognition-mainly, metacognition-writing-balanced, writing-mainly, to writing-only. This adjustable range keeps learners as active decision-makers, balancing the need for immediate performance improvement with long-term metacognitive development.

Thus, AI-powered feedback not merely as a performance optimizer or error corrector but as a high-level facilitator that promotes self-regulation, feedback literacy, and learner agency.

4. Methods of Evaluation

The study will adopt a Design-Based Research (DBR) approach (Reeves, 2006) to iteratively design, implement, and refine the proposed platform in authentic EFL writing classrooms. The process will involve close collaboration among researchers, teachers, and learners.

Participants will be recruited from university students with different EFL proficiency from novice to advanced levels. Data will be collected from writing outputs (engagement and rubric-based performance), system logs (feedback requests, agency level selections, analytics dashboard interactions), questionnaire measures of self-regulation and learner agency, and semi-structured interviews with students and teachers. A quasi-experimental study will be conducted between a metacognition-support condition versus a conventional AI-feedback condition. Outcome measures contain gains in writing performance, metacognitive awareness, and learner agency perceptions.

5. Conclusion and Future Work

This research addresses the challenge of fostering both writing performance and learner agency in EFL contexts. It introduces an AI-powered support system that integrates metacognitive prompts, adjustable agency control, and LA dashboard into a digital writing environment. The goal is to design AI scaffolds that enhances immediate writing performance while fostering self-regulation and learner agency. Expected contributions include: 1) empirical evidence on how AI scaffolds can improve both writing performance and metacognitive development; 2) theoretical advancement by extending self-regulated learning and agency frameworks into AI-enhanced writing; 3) practical design principles for support systems that enhance learner agency. Future work will focus on refining prompt design through human-centered approaches and evaluating the platform’s effectiveness in authentic EFL classroom settings.

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