

A Conceptual Framework for AI-Driven Collaborative Learning in Learning Management Systems

Kerangka Konseptual untuk Pembelajaran Kolaboratif Berasaskan Kecerdasan Buatan dalam Sistem Pengurusan Pembelajaran

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ABSTRACT

This study proposes a conceptual framework for AI-driven collaborative learning (AI-CoL) in Learning Management Systems (LMS), using UKMFolio as the contextual reference. The proposed framework supports the evolution of conventional LMS platforms towards intelligent learning ecosystems that enhance collaboration, engagement, and learning effectiveness. Many LMSs continue to function primarily as content delivery and administrative systems with limited intelligent support for collaborative learning activities. This study adopts an exploratory qualitative approach involving a system walkthrough and feature analysis of UKMFolio, expert review sessions with senior academics experienced in LMS and Artificial Intelligence (AI) implementation in higher education. The findings from both phases were analysed thematically and synthesised to develop the proposed conceptual framework. The findings identified five key collaborative learning challenges within UKMFolio and based on these findings, five AI-driven mechanisms were proposed to contribute towards forming the foundation of a more intelligent LMS ecosystem. This study contributes by proposing an AI-Driven conceptual framework and provides guidance for higher education institutions, LMS administrators, as well as system developers in planning AI integration initiatives towards intelligent, human-centred, and collaborative digital learning in LMS ecosystems.

Keywords: Artificial Intelligence, Collaborative Learning, Learning Management Systems, UKMFolio, Digital Transformation

ABSTRAK

Kajian ini mencadangkan kerangka konseptual untuk pembelajaran kolaboratif dipacu kecerdasan buatan (AI-CoL) dalam Sistem Pengurusan Pembelajaran, menggunakan UKMFolio sebagai rujukan kontekstual. Rangka kerja yang dicadangkan menyokong evolusi platform LMS konvensional ke arah ekosistem pembelajaran pintar yang meningkatkan kerjasama, penglibatan dan keberkesanan pembelajaran. Banyak LMS berfungsi sebagai sistem penyampaian kandungan dan pentadbiran tetapi terhad dari aspek sokongan pintar yang menyokong aktiviti pembelajaran kolaboratif. Kajian ini menggunakan pendekatan kualitatif yang melibatkan tinjauan sistem dan analisis ciri UKMFolio, sesi semakan pakar dengan ahli akademik yang berpengalaman dalam pelaksanaan LMS dan kecerdasan buatan dalam pendidikan tinggi. Dapatan daripada kedua-dua fasa dianalisis secara tematik dan disintesis untuk membangunkan kerangka konseptual yang dicadangkan. Penemuan ini mengenal pasti lima cabaran pembelajaran kolaboratif utama dalam UKMFolio dan berdasarkan penemuan ini, lima mekanisme dipacu AI telah dicadangkan untuk membentuk asas ekosistem LMS yang lebih pintar. Kajian ini mencadangkan kerangka konseptual dipacu AI dan menyediakan panduan untuk institusi pengajian tinggi, pentadbir LMS, serta pembangun sistem dalam merancang inisiatif penyepaduan AI ke arah pembelajaran digital pintar, berpusatkan manusia dan kolaboratif dalam ekosistem LMS.

Kata kunci: Kecerdasan Buatan, Pembelajaran Kolaboratif, Sistem Pengurusan Pembelajaran, UKMFolio, Transformasi Digital

INTRODUCTION

Learning Management Systems (LMS) have become a central component of digital learning in higher education, providing platforms for content delivery, communication, assessment, and learning management. At Universiti Kebangsaan Malaysia, UKMFolio serves as the official LMS supporting teaching and learning activities. While LMS platforms have successfully facilitated online and blended learning, many continue to function primarily as repositories of learning materials and administrative tools, with limited intelligent capabilities to support collaborative learning processes (Liu & Yu 2023).

Recent advances in Artificial Intelligence (AI) have demonstrated potential in supporting learner engagement, adaptive learning, learning analytics, and intelligent decision-making. Limited studies have explored how AI-driven mechanisms can be systematically integrated into LMS environments to enhance collaborative learning (Ouyang & Zhang 2024). Existing research often focuses on individual AI applications or specific learning outcomes rather than providing a holistic perspective on how AI can address collaborative learning challenges. Therefore, using UKMFolio as the contextual reference, this study proposes the AI-CoL framework.

RELATED WORK

Beyond content delivery and course administration, LMS environments provide tools for communication, discussion, assessment, and group-based activities that facilitate collaborative learning among students (Wagino et al. 2023). Collaborative learning encourages knowledge sharing, interaction, and teamwork, enabling learners to construct knowledge collectively through active participation. However, existing studies suggest that many LMS platforms continue to provide limited support for meaningful collaboration and learner engagement, often requiring substantial instructor intervention and reliance on external communication tools to facilitate collaborative activities (Veluvali & Suriseti 2022; Thangavel 2024).

Recent advances in AI have accelerated the development of intelligent learning environments. The integration of AI technologies has created opportunities for LMS platforms to evolve beyond their traditional roles towards more intelligent learning ecosystems (Liu & Yu 2023). In collaborative learning contexts, AI-driven technologies can support participation monitoring, communication facilitation, adaptive learning recommendations, and predictive intervention strategies. Furthermore, AI-driven learning analytics have demonstrated potential in enhancing computer-supported collaborative learning by providing meaningful insights into learner behaviour, participation patterns, and collaborative engagement (Ouyang & Zhang 2024).

METHODOLOGY

This study adopted a qualitative approach to identifying key challenges, and developing conceptual frameworks based on expert insights and contextual observations (Mills et al. 2025). First, a system walkthrough and feature analysis were conducted to examine existing collaborative learning functionalities within UKMFolio. Key features related to group activities, communication, participation monitoring, learning support, and analytics were reviewed to identify the challenges (Abdurahman et al. 2025). Second, expert review sessions were conducted with two senior academics who possess experience in LMS management and AI implementation in higher education institutions. The expert reviews aimed to gather insights regarding the identified collaborative learning challenges and explore potential AI-driven approaches. Finally, the findings from the system walkthrough and expert reviews were analysed using thematic analysis. Thematic analysis is widely used to identify, organise, and interpret patterns within qualitative data and can support the development of conceptual models and frameworks through the systematic synthesis of emerging themes (Naeem et al. 2023). The identified themes were subsequently integrated to develop the conceptual framework.

RESULTS AND DISCUSSION

The findings identified five key challenges affecting collaborative learning within LMS environments as shown in Table 1. These findings suggest that while UKMFolio provide essential tools for content

delivery and course administration, their support for collaborative learning remains largely dependent on manual facilitation and external communication platforms.

TABLE 1. Collaborative Learning Challenges Identified in UKMFolio.

Collaborative Learning Challenge	Description
Group Coordination	Reliance on manual group management
Participation Monitoring	Limited visibility of individual contribution
Communication & Engagement	Low interaction and fragmented communication
Personalisation	Uniform learning support
Analytics & Prediction	Lack of proactive intervention capability

The experts proposed practical approaches for addressing the limitations as shown in Table 2.

TABLE 2. Proposed AI-Driven Mechanisms and Example Applications in UKMFolio.

AI-Driven Mechanism	Example Features
Intelligent Group Formation	Skill-based grouping, automated team allocation
Participation Analytics	Contribution tracking, activity summaries
AI Communication Support	Discussion prompts, automated reminders
Adaptive Learning Support	Personalised feedback and recommendations
Predictive Analytics	Early alerts and intervention support

The findings from the system walkthrough and expert reviews were subsequently synthesised to develop the AI-CoL framework. As illustrated in Figure 2, the framework comprises three interconnected constructs: collaborative learning challenges, AI-driven mechanisms, and collaborative learning outcomes through intelligent and adaptive support mechanisms.

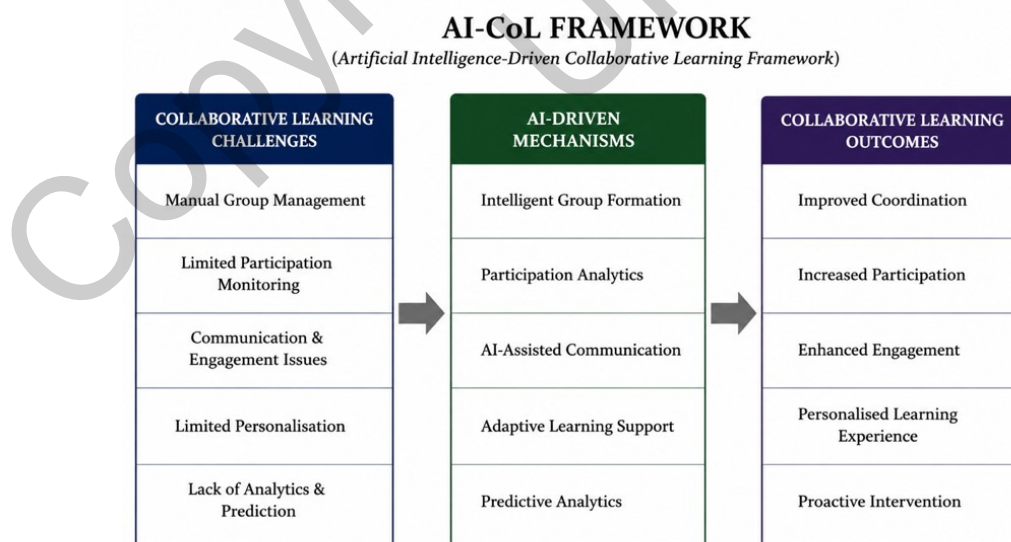


FIGURE 2. AI-CoL Framework.

Within the framework, collaborative learning challenges represent limitations commonly observed in current LMS environments. AI-driven mechanisms function as intervention strategies to the limitations. The implementation of these mechanisms is expected to contribute towards improved group

coordination, increased student participation, enhanced engagement, personalised learning experiences, and more proactive learning intervention.

CONCLUSION

This study proposed a conceptual framework that integrates AI-driven mechanisms to enhance learning outcomes in LMS environments. This study contributes to the growing body of knowledge on Artificial Intelligence in Education (AIED) that links collaborative learning challenges, AI-driven mechanisms, and collaborative learning outcomes. The framework may serve as a reference for higher education institutions, LMS administrators, and system developers in planning future AI integration initiatives and supporting the evolution of conventional LMS platforms towards more intelligent learning ecosystems.

However, this study has several limitations. The framework was developed based on a walkthrough analysis of a single LMS environment and insights obtained from two experts, which may limit the generalisability of the findings. Future studies may validate and refine the framework through broader stakeholder involvement, including students, lecturers, and LMS administrators. Further research may also explore the implementation and evaluation of AI-driven collaborative learning features to examine their effectiveness in improving engagement, collaboration, and learning outcomes in higher education.

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