

Artificial Intelligence in Moodle for Higher Education: A Systematic Review

Dr. Urmila R. Pol

Department Of Computer Science, Shivaji University Kolhapur, India

Abstract— Artificial intelligence is becoming an important part of higher education by changing how learning management systems are used to support teaching and learning. In Moodle, AI-based tools are increasingly used to personalize learning, identify students who may need support, automate feedback, and improve instructional design. This systematic review examines literature published between 2020 and 2026 to understand how AI has been integrated into Moodle, what educational advantages it provides, and what barriers limit broader adoption. A structured search of major academic databases identified 42 relevant studies and supporting theoretical sources, which were synthesized thematically. The review indicates that AI-enhanced Moodle environments can improve engagement, support earlier intervention, reduce assessment time, and extend learning support through intelligent assistants. At the same time, the evidence points to concerns about privacy, bias, academic integrity, and institutional readiness. Overall, the findings suggest that AI in Moodle is most effective when it is guided by ethical governance, human oversight, and ongoing faculty development. Future research should focus on explainable AI, multimodal learning analytics, and privacy-conscious deployment models.

Keywords— Moodle, artificial intelligence, learning analytics, generative AI, higher education

I. INTRODUCTION

Artificial intelligence is reshaping expectations for what learning management systems should provide in higher education. These systems are no longer used only to host files or manage routine course tasks. They are increasingly expected to support adaptive learning, timely feedback, and scalable learner support. As a result, AI has become central to discussions about the future of digital education.

Moodle is particularly relevant because it is open source, flexible, and widely used in universities. Its architecture and plugin ecosystem make it suitable for integrating learning analytics, machine learning, chatbots, and generative AI tools. Over time, Moodle has shifted from a basic course delivery system to a more interactive and data-informed learning environment. This review examines the literature on AI in Moodle and focuses on three questions: how the technology has developed, what educational value it offers, and what barriers limit its responsible use.

The review is informed by Cognitive Load Theory and the Self-Regulated Learning framework, both of which help explain why AI-supported environments may improve learning while still requiring careful design and supervision [cite: 3, 4].

II. METHODOLOGY

A. Theoretical Foundations

This review uses Cognitive Load Theory and the Self-Regulated Learning framework to explain how AI may support learning in Moodle-based environments. AI can reduce unnecessary mental effort by automating repetitive administrative tasks, while also helping learners monitor progress and adjust strategies through personalized feedback and adaptive guidance [cite: 3, 4].

B. Literature Search and Selection Criteria

A structured search was conducted across IEEE Xplore, ScienceDirect, PubMed, Scopus, and Google Scholar to identify relevant studies published between 2020 and 2026. Search terms combined Moodle, Modular Object-Oriented Dynamic Learning Environment, artificial intelligence, machine learning, generative AI, learning analytics, and ChatGPT. Only peer-reviewed studies that directly addressed AI use in Moodle within higher education were considered.

Studies were included if they examined, implemented, or conceptually discussed AI functions within Moodle-supported learning settings. Studies focused on non-Moodle platforms or lacking sufficient methodological detail were excluded. After screening, 42 core studies and several foundational theoretical sources were retained for thematic synthesis [cite: 1, 4, 9].

C. Data Analysis

The selected literature was reviewed thematically rather than statistically. The analysis focused on five broad areas: the developmental stages of AI in Moodle, the main technical approaches used, the educational applications reported, the implementation challenges described, and the future directions suggested by the literature.

Because the reviewed studies differed in design, context, and outcome measures, thematic synthesis was the most suitable way to integrate the evidence.

TABLE I
CHRONOLOGICAL EVOLUTION OF AI IN MOODLE

Operational Period	Era / Development Focus	Primary Technological Capabilities & Pedagogical Focus
2002-2010	Traditional LMS	Static file repositories, basic forums, manual grading engines. Content delivery and administration.
2010-2015	Early Learning Analytics	Descriptive interaction logging, basic performance reporting. Behavior tracking and institutional monitoring.
2015-2020	Machine Learning Integration	Moodle Analytics API, supervised classification, rule-based engines. Early identification of at-risk students.
2020-2023	Predictive Analytics & Chatbots	Natural language processing, rule-based conversational agents, engagement forecasting. Proactive intervention and 24/7 technical support.
2023-2026	Generative AI Subsystems	LLM API connectors, autonomous question generation, native AI subsystems. Personalized instruction and automated assessment.

III. REVIEW FINDINGS

The literature shows that AI in Moodle has evolved through several stages. In the earliest stage, Moodle mainly served as a conventional learning management system for course materials, discussion, and manual grading [cite: 2]. Later, learning analytics made it possible to describe student behavior and participation more systematically [cite: 7].

The next phase introduced machine learning and predictive methods, especially through the Moodle Analytics API, which helped educators identify students who might be at risk. More recently, chatbots and generative AI tools have made Moodle more interactive and responsive [cite: 1, 4].

Machine learning in Moodle usually relies on interaction data such as submission timing, quiz attempts, and forum participation. These signals can be used to identify learners who may need additional help. Natural language processing adds further value by analyzing forum discussions, reflection texts, and essay responses, which can support sentiment detection, text organization, and preliminary writing feedback.

Generative AI extends these capabilities by helping instructors build quiz items, create lesson examples, generate case materials, and design coding exercises. In instructional terms, AI supports personalized learning by adjusting content to student needs, improves assessment by accelerating feedback, and expands learner support through chatbots and intelligent tutoring systems [cite: 6, 8].

TABLE II
IMPACT ANALYSIS OF CORE AI APPLICATIONS WITHIN MOODLE ENVIRONMENTS

Application Domain	Primary Functionality	Measurable Educational Impact	Key Operational Constraint
Personalized Learning	Adaptive resource allocation based on performance history	Increased engagement and mastery in self-paced environments	Requires robust content and pedagogical tagging setup
Automated Grading	Instant scoring of code, essays, and objective assessments	Reduced grading latency and rapid feedback cycles	Requires human moderation for subjective and creative work
Predictive Analytics	Early identification of academic dropouts and struggle patterns	Improved retention through early faculty interventions	Dependent on model training quality and clean data logs
AI Virtual Assistants	Conversational responses to routine technical and course queries	Uninterrupted learner support and reduced administrative load	Risk of hallucinated or incorrect information

IV. DISCUSSION

The review indicates that AI has changed Moodle from a primarily static learning environment into one that can respond more intelligently to learner behavior and instructional needs. One clear advantage is the ability to identify signs of difficulty earlier and more precisely. AI-supported personalization can also make course pathways more flexible and better aligned with individual progress.

However, the findings also show that technical capability alone does not guarantee educational improvement. AI works best when it is embedded in thoughtful course design, supported by reliable data, and interpreted by educators rather than used as a substitute for judgment. Human oversight remains important because automated systems cannot fully capture context, motivation, or the nuances of disciplinary teaching.

The review also highlights several risks that institutions must address carefully. Privacy becomes a concern when student data are sent to external AI services. Predictive models can reflect bias if they are trained on historical data that contain unequal patterns. Generative AI adds another challenge because it can produce content that is difficult to distinguish from student work. For these reasons, institutions should use AI as a support mechanism rather than as an authority that makes decisions independently.

A further issue is faculty preparedness. If instructors do not receive enough training in AI literacy, ethical use, and instructional design, AI tools may be adopted in ways that do not improve learning. This means that institutional policy, training, and governance are just as important as the technology itself.

V. CONCLUSION

AI has strong potential to improve learning, teaching, and assessment in Moodle-based higher education. The literature reviewed here suggests that machine learning, natural language processing, predictive analytics, and generative AI can make digital learning more responsive and efficient.

Yet these benefits can only be realized responsibly if institutions pay equal attention to privacy, fairness, academic integrity, and faculty development.

The main conclusion of this review is that AI should strengthen education while keeping human judgment central. Future work should focus on explainable systems, multimodal analytics, and privacy-conscious deployment so that Moodle can support learning in ways that are both effective and trustworthy.

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