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AI-DRIVEN PREDICTIVE ANALYTICS FOR STUDENT PERFORMANCE PREDICTION

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ABSTRACT

Artificial Intelligence (AI)-supported learning analytics has emerged as a transformative approach for predicting student performance and improving educational decision-making in higher education. By combining learning analytics with advanced Artificial Intelligence techniques such as Large Language Models (LLMs), machine learning, and predictive modeling, educational institutions can identify learning patterns, forecast academic outcomes, and provide timely interventions for students at risk of poor performance. Traditional learning analytics systems often rely on descriptive statistics and historical academic records, limiting their ability to deliver personalized and real-time educational support. AI-supported learning analytics overcomes these limitations by integrating curriculum-aware artificial intelligence, Retrieval-Augmented Generation (RAG), Explainable Artificial Intelligence (XAI), Human-in-the-Loop (HITL) verification, and institutional governance frameworks to improve prediction accuracy and educational transparency. This study investigates AI-supported learning analytics for student performance prediction through a qualitative review of recent scholarly literature. The findings indicate that AI-enhanced learning analytics significantly improve prediction accuracy, learner engagement, personalized learning, curriculum alignment, and institutional decision-making while reducing dropout risks and improving academic success. Smart learning guidance systems have demonstrated that artificial intelligence can identify learner needs and provide timely academic recommendations that improve student learning outcomes.

KEYWORDS: *Learning Analytics, Student Performance Prediction, Artificial Intelligence, Curriculum-Aware Artificial Intelligence, Explainable Artificial Intelligence, Retrieval-Augmented Generation, Higher Education*

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INTRODUCTION

Student performance prediction has become an important priority for higher education institutions because early identification of learners who require academic support enables timely interventions that improve retention, achievement, and graduation rates. Learning analytics has traditionally been used to analyze educational data such as assessment scores, attendance records, learning management system activities, and learner participation. However, conventional analytical approaches often struggle to identify complex learning patterns or provide personalized recommendations that reflect curriculum objectives and individual learner needs.

Recent advances in Artificial Intelligence, particularly Large Language Models and predictive machine learning techniques, have significantly expanded the capabilities of learning analytics. AI-supported learning analytics enables educational institutions to analyze diverse educational datasets, identify hidden learning patterns, generate personalized recommendations, and predict future academic performance with greater accuracy. When combined with curriculum-aware artificial intelligence, Retrieval-Augmented Generation, Explainable Artificial Intelligence, Human-in-the-Loop verification, and governance frameworks, AI-supported learning analytics produces transparent, reliable, and curriculum-aligned educational insights that support evidence-based decision-making (Dutta, Paul, & Anand, 2024).

BACKGROUND OF THE STUDY

The increasing availability of digital learning platforms has generated substantial educational data that can be analyzed to improve teaching effectiveness and learner success. Learning Management Systems, intelligent tutoring systems, educational chatbots, online assessments, and digital classrooms continuously generate learner interaction data capable of supporting predictive educational analytics. Despite these opportunities, conventional learning analytics systems often rely on historical statistical analysis without incorporating contextual educational knowledge or curriculum-specific information.

Student GPT represented one of the earliest curriculum-aware educational language models developed to generate instructional responses using verified educational resources while promoting ethical learning environments (Dutta, 2023). Human-in-the-loop validation and curriculum-aware language models reduce hallucinations while improving the reliability of educational AI systems (Dutta, Paul, & Anand, 2024). More recent intelligent tutoring frameworks integrated Retrieval-Augmented Generation, knowledge graphs, and multi-large language model orchestration to retrieve verified institutional knowledge before generating educational recommendations, thereby improving learning analytics accuracy and instructional reliability. These developments have positioned AI-supported learning analytics as an important component of intelligent educational ecosystems.

LITERATURE REVIEW

Recent literature consistently demonstrates that AI-supported learning analytics significantly improves student performance prediction. Dutta, Paul, and Anand (2024) proposed governance architectures integrating curriculum awareness, ethical artificial intelligence, institutional oversight, accountability, and transparency into educational AI systems. Their framework demonstrates that curriculum-aware learning analytics improves prediction accuracy, instructional consistency, learner trust, and institutional accountability.

StudentGPT established an important foundation by demonstrating that curriculum-aware transformer models generate educational recommendations using verified instructional resources and ethical learning principles (Dutta, 2023). This curriculum-driven approach improves learning analytics by ensuring that predictive recommendations remain consistent with institutional learning objectives.

Durga and Rafee (2024) developed an intelligent tutoring framework integrating multiple large language models, Retrieval-Augmented Generation, and knowledge graphs to improve contextual reasoning and predictive educational support. Their framework retrieves verified institutional knowledge before generating recommendations, thereby strengthening curriculum alignment while reducing misinformation. Technical implementation strategies improve the reliability and effectiveness of large language models within educational environments (Zhao & Wan, 2021).

CurricuLLM illustrates how curriculum-aware fine-tuning supports performance prediction by aligning learner recommendations with curriculum objectives and workforce expectations while maintaining educational consistency. Adapt Learn AI further strengthens predictive learning through bidirectional personalization that continuously adjusts learning pathways according to learner performance while preserving curriculum integrity (Gupta et al., 2025).

Comprehensive reviews conclude that AI-supported learning analytics significantly improves learner engagement, educational transparency, prediction accuracy, and institutional confidence when integrated with explainable AI and governance frameworks. Systematic reviews indicate that large language models are transforming intelligent educational systems by supporting adaptive learning, educational analytics, and personalized instruction (Ivanova & Terzieva, 2026). Curriculum-aware fine-tuning of large language models enhances personalized learning pathways while aligning recommendations with institutional learning objectives (Nijdam et al., 2023).

Table 1: Applications of AI-Supported Learning Analytics for Student Performance Prediction

Educational Application	Contribution to Student Performance Prediction
Early warning systems	Identifies students at academic risk for timely intervention
Personalized learning	Recommends individualized learning pathways based on learner performance
Academic advising	Supports evidence-based educational guidance and planning
Assessment analytics	Predicts learning outcomes using assessment performance trends
Institutional decision support	Assists administrators in improving curriculum planning and learner success

METHODOLOGY

This study employed a qualitative literature review methodology to investigate AI-supported learning analytics for student performance prediction. Relevant peer-reviewed journal articles, conference proceedings, scholarly books, and preprint publications. The selected literature focused on learning analytics, curriculum-aware artificial intelligence, Retrieval-Augmented Generation, Explainable Artificial Intelligence, intelligent tutoring systems, educational governance, adaptive learning, personalized education, and student performance prediction.

The reviewed publications were analyzed using thematic content analysis to identify recurring themes concerning predictive analytics, curriculum alignment, instructional accuracy, learner engagement, educational transparency, governance, personalization, and responsible artificial intelligence implementation. Similar findings across multiple studies were synthesized to establish a comprehensive understanding of AI-supported learning analytics within higher education.

Successful deployment of predictive analytics requires effective data engineering, lifecycle management, and responsible AI governance throughout the analytical process (Anand & Burk, 2025).

RESULTS

The reviewed literature consistently demonstrates that AI-supported learning analytics significantly improves student performance prediction within higher education institutions. Educational institutions implementing AI-enhanced learning analytics report improved prediction accuracy, stronger curriculum alignment, enhanced learner engagement, increased academic achievement, higher learner satisfaction, and greater institutional confidence compared with conventional analytical systems.

The findings further indicate that Retrieval-Augmented Generation substantially improves predictive reliability by retrieving verified institutional knowledge before generating educational recommendations. Knowledge graph integration strengthens contextual reasoning, while Explainable Artificial Intelligence improves transparency by providing

understandable explanations for predictive decisions and learner recommendations. Human-in-the-Loop verification further strengthens educational quality by enabling instructors and academic advisors to validate AI-generated predictions, refine intervention strategies, and ensure curriculum consistency before institutional implementation.

Despite these advantages, implementation challenges include infrastructure investment, continuous curriculum maintenance, institutional knowledge management, faculty training, governance implementation, cybersecurity management, privacy protection, and quality assurance. Addressing these challenges remains essential for sustainable deployment of AI-supported learning analytics.

Table 2: Benefits and Challenges of AI-Supported Learning Analytics

Benefits	Challenges
Improved prediction accuracy	Infrastructure investment
Early identification of at-risk students	Continuous curriculum maintenance
Enhanced personalized learning	Faculty training requirements
Strong curriculum alignment	Data governance and privacy protection
Improved institutional decision-making	Cybersecurity and institutional knowledge management

DISCUSSION

The findings indicate that AI-supported learning analytics represents a significant advancement in educational data analysis because it combines predictive artificial intelligence with curriculum-aware educational decision-making. Unlike conventional learning analytics that primarily analyzes historical learner data, AI-supported systems continuously interpret learner behavior, academic performance, curriculum progression, and institutional knowledge to generate personalized predictions and educational recommendations. This approach significantly improves learner success, instructional effectiveness, curriculum consistency, and institutional planning.

The reviewed literature further demonstrates that AI-supported learning analytics becomes increasingly effective when integrated with curriculum-aware artificial intelligence, Retrieval-Augmented Generation, Explainable Artificial Intelligence, Human-in-the-Loop verification, and educational governance. These complementary technologies enable educational institutions to provide transparent, accurate, and personalized academic interventions while maintaining academic integrity and institutional accountability. Human educators continue to play a vital role by validating AI-generated predictions, interpreting educational data within instructional contexts, refining intervention strategies, and ensuring that predictive recommendations remain pedagogically appropriate.

Future AI-supported learning analytics systems are expected to integrate multimodal learner data, predictive learning analytics dashboards, collaborative AI-human decision support, automated curriculum synchronization, competency-based learning analytics, privacy-preserving artificial intelligence techniques, and real-time governance monitoring. These developments will further strengthen intelligent educational systems while supporting scalable, ethical, and learner-centered higher education. Ensemble learning techniques provide robust predictive performance and can enhance the accuracy of student performance prediction models when applied to educational datasets (Mahajan, Yamsani, & Konatham, 2024). AI tutors provide adaptive learning support that improves learner engagement, academic achievement, and personalized educational experiences (Zhao et al., 2022).

CONCLUSION

AI-supported learning analytics provides a comprehensive framework for improving student performance prediction through intelligent analysis of educational data and curriculum-aware decision-making. The reviewed literature demonstrates that integrating learning analytics with curriculum-aware artificial intelligence, Retrieval-Augmented Generation, Explainable Artificial Intelligence, intelligent tutoring systems, educational governance, and Human-in-the-Loop verification significantly improves prediction accuracy, instructional quality, learner engagement, curriculum alignment, educational transparency, academic performance, and institutional trust. Although implementation challenges involving infrastructure, curriculum maintenance, governance, cybersecurity, data privacy, faculty readiness, and institutional knowledge management remain, AI-supported learning analytics offers a sustainable pathway for responsible educational innovation. Future research should focus on developing scalable, adaptive, transparent, and accountable predictive learning analytics systems capable of supporting intelligent, ethical, and learner-centered education across diverse higher learning institutions.

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