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ARTIFICIAL INTELLIGENCE (AI) APPROACHES IN HIGHER EDUCATION: A THEORETICAL FOUNDATION FOR THE AI-INTEGRATED TEACHING MANAGEMENT FRAMEWORK[i]

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Abstract:
The rapid advancement of artificial intelligence (AI) is fundamentally transforming teaching, learning, and educational management in the context of digital transformation. This study employed a Systematic Literature Review (SLR) following the PRISMA guidelines to analyze 44 representative studies on AI in higher education published between 2011 and 2026. The findings identify and synthesize six major AI approaches in higher education and reveal their evolutionary progression from learning analytics, AI adoption, and AI governance toward AI literacy and the integration of AI into teaching and learning. Despite the rapid growth of AI research, existing studies have not yet established a comprehensive management framework that systematically integrates educational data, AI technologies, governance, and the entire teaching and learning process. To address this research gap, the study proposes the AI-Integrated Teaching Management Framework (AI-ITMF) based on a systems approach that integrates Systems Theory, the Plan - Do - Check - Act (PDCA) continuous improvement cycle. The proposed framework provides a theoretical foundation and a practical reference for

[i] CÁC TIẾP CẬN TRÍ TUỆ NHÂN TẠO (AI) TRONG GIÁO DỤC ĐẠI HỌC: NỀN TẢNG LÝ THUYẾT CHO KHUNG QUẢN LÝ DẠY HỌC TÍCH HỢP AI

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implementing AI in higher education in an effective, responsible, and sustainable manner.

Keywords: Artificial Intelligence (AI); higher education; AI-integrated teaching management; AI-Integrated Teaching Management Framework (AI-ITMF); digital transformation

Tóm tắt:
Sự phát triển nhanh chóng của trí tuệ nhân tạo (AI) đang tạo ra những chuyển biến căn bản đối với hoạt động dạy học, học tập và quản lý giáo dục trong bối cảnh chuyển đổi số. Nghiên cứu này sử dụng phương pháp tổng quan tài liệu có hệ thống (Systematic Literature Review - SLR) theo hướng dẫn PRISMA để phân tích 44 nghiên cứu tiêu biểu về AI trong giáo dục đại học được công bố trong giai đoạn 2011-2026. Kết quả nghiên cứu xác định và tổng hợp sáu cách tiếp cận chủ yếu đối với AI trong giáo dục đại học, đồng thời chỉ ra quá trình phát triển từ phân tích học tập, ứng dụng AI và quản trị AI, đến năng lực AI và tích hợp AI vào hoạt động dạy và học. Mặc dù các nghiên cứu về AI trong giáo dục đang gia tăng nhanh chóng, các nghiên cứu hiện có vẫn chưa xây dựng được một khung quản lý toàn diện, có khả năng tích hợp một cách có hệ thống dữ liệu giáo dục, công nghệ AI, quản trị và toàn bộ quá trình dạy học. Nhằm giải quyết khoảng trống nghiên cứu này, nghiên cứu đề xuất Khung Quản lý Dạy học Tích hợp AI (AI-Integrated Teaching Management Framework - AI-ITMF) dựa trên cách tiếp cận hệ thống, kết hợp Lý thuyết Hệ thống (Systems Theory) với chu trình cải tiến liên tục Plan - Do - Check - Act (PDCA). Khung đề xuất cung cấp nền tảng lý thuyết và cơ sở tham chiếu thực tiễn cho việc triển khai AI trong giáo dục đại học theo hướng hiệu quả, có trách nhiệm và bền vững.

Từ khóa: Trí tuệ nhân tạo (AI); giáo dục đại học; quản lý dạy học tích hợp AI; Khung Quản lý Dạy học Tích hợp AI (AI-ITMF); chuyển đổi số.

1. Introduction

1.1 Research Background

The Fourth Industrial Revolution, together with the rapid advancement of Artificial Intelligence (AI), is fundamentally reshaping higher education (HE). AI is transforming not only teaching and learning practices but also institutional governance, academic management, and the development of digital university ecosystems, enabling data-driven educational management supported by intelligent technologies (Bond *et al.*, 2024 [4]; García-Peñalvo, 2023 [14]; Luckin, 2018 [23]; OECD, 2021 [27]).

Based on a synthesis of studies published between 2011 and 2026, the evolution of AI in higher education can be broadly categorized into three phases.

The first phase (2011-2016) established the foundations for AI applications, with particular emphasis on Learning Analytics and data-driven decision-making (Siemens & Long, 2011 [40]; Ifenthaler & Yau, 2020 [17]).

The second phase (2017-2022) expanded AI applications to include intelligent tutoring systems, adaptive learning, AI-supported assessment, and personalized learning (Holmes *et al.*, 2019 [15]; Ouyang *et al.*, 2022 [28]; Popenici & Kerr, 2017 [31]). Since 2023, the emergence of Generative AI and Large Language Models (LLMs) has shifted research toward institution-level issues, including AI adoption, AI governance, AI literacy, AI Across the Curriculum, data governance, and AI ethics, positioning AI as a strategic component of smart universities and digital transformation (McDonald *et al.*, 2024 [25]; Mah & Groß, 2024 [24]; Southworth *et al.*, 2023 [41]; Neumann *et al.*, 2026 [26]).

Despite the rapid growth of AI research in higher education, most existing studies have addressed AI from isolated perspectives, such as Learning Analytics, AI Adoption, AI Governance, Smart University, AI Literacy, or AI Across the Curriculum. Consequently, a comprehensive management framework that systematically integrates educational data, AI technologies, governance, and the entire teaching and learning process has yet to be established, leaving a significant theoretical and managerial research gap (Khalil *et al.*, 2024 [20]; McDonald *et al.*, 2024 [25]; Katsamakas *et al.*, 2024 [19]; Neumann *et al.*, 2026 [26]).

To address this gap, the present study employs a Systematic Literature Review (SLR) to synthesize major AI approaches in higher education, identify existing research gaps, and propose the AI-Integrated Teaching Management Framework (AI-ITMF) from a systems perspective. The proposed framework integrates six major AI approaches through a Data Feedback Loop operating within the Plan - Do - Check - Act (PDCA) continuous improvement cycle, thereby supporting data-driven teaching management in the context of digital transformation and the development of smart universities (Katsamakas *et al.*, 2024 [19]; Liew *et al.*, 2024 [22]; UNESCO, 2023 [44]).

1.2 Research Objectives

This study pursues two primary objectives:

1) to synthesize and systematize the six major AI approaches relevant to AI-integrated teaching management in higher education; and
2) to propose the AI-Integrated Teaching Management Framework (AI-ITMF) from a systems perspective as a theoretical foundation for the effective, responsible, and sustainable implementation of AI in higher education institutions.

2. Methodology

2.1 Research Design

This study employed a Systematic Literature Review (SLR) to identify, analyze, and synthesize major AI approaches in higher education, providing the foundation for

developing the AI-Integrated Teaching Management Framework (AI-ITMF) (Khalil *et al.*, 2024 [20]; Liew *et al.*, 2024 [22]; Ouyang *et al.*, 2022 [28]).

The SLR approach was selected because it enables the systematic synthesis of scientific evidence, minimizes selection bias, and facilitates the identification of emerging research trends and knowledge gaps. The review followed the PRISMA 2020 guidelines and combined content analysis with thematic coding to classify AI approaches in higher education (Page *et al.*, 2021 [29]; Wu *et al.*, 2024 [46]).

Following the screening process, the selected studies were analyzed according to their research objectives, AI application domains, implementation levels, governance models, and relevance to AI-integrated teaching management. The synthesis identified six major AI approaches, which subsequently served as the conceptual basis for developing the AI-ITMF from a systems perspective (Khalil *et al.*, 2024 [20]; Hou, 2025 [16]; Liew *et al.*, 2024 [22]; Neumann *et al.*, 2026 [26]).

2.2 Study Selection Criteria

The literature was selected according to predefined inclusion and exclusion criteria to ensure the scientific rigor, reliability, and relevance of the review. These criteria were established following the Systematic Literature Review (SLR) methodology and the PRISMA 2020 guidelines, thereby enhancing the transparency and reproducibility of the review process (Page *et al.*, 2021 [29]).

Table 1: Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Peer-reviewed journal articles, international conference proceedings, policy reports, or academic books	News articles, magazines, blogs, or non-peer-reviewed publications
Publications in English published between 2011 and 2026	Publications published before 2011
Studies focusing on AI in higher education	Studies on AI in K–12 education or non-educational contexts
Studies addressing AI applications, adoption, governance, or management	Studies focusing solely on AI algorithms or technical methods without educational applications
Studies related to teaching and learning, learning management, or university governance	Studies lacking sufficient information for content analysis

Note: The year 2011 was selected as the starting point because it marks the emergence of Learning Analytics as a distinct research field in higher education. The seminal work of Siemens and Long (2011) established the foundations for learning analytics, data-driven decision-making, and educational data governance, providing an important basis for subsequent AI research in higher education (Siemens & Long, 2011 [40]; Ifenthaler & Yau, 2020 [17]; Ouyang *et al.*, 2022 [28]).

2.3 PRISMA-Based Literature Review Procedure

The literature review was conducted in accordance with the PRISMA 2020 guidelines, following four sequential stages: Identification, Screening, Eligibility, and Inclusion. This procedure enhances the transparency, reproducibility, and methodological rigor of the

review process (Page *et al.*, 2021 [29]). The literature search was performed across six major academic databases, including Scopus, Web of Science, ERIC, SpringerLink, ScienceDirect, and IEEE Xplore. The search strategy employed combinations of keywords related to AI in higher education, including Artificial Intelligence, AI Adoption, AI Governance, Learning Analytics, Smart University, AI Literacy, Generative AI, AI Across the Curriculum, and Educational Management. These search terms were derived from previous systematic reviews and seminal studies to ensure comprehensive coverage of the major AI research approaches in higher education (Bond *et al.*, 2024 [4]; Khalil *et al.*, 2024 [20]; Ouyang *et al.*, 2022 [28]).

The initial search identified 186 records. After removing 32 duplicate records, 154 studies remained for title and abstract screening. Subsequently, 89 studies were excluded for not meeting the predefined selection criteria. The remaining 65 full-text articles were assessed for eligibility, resulting in the exclusion of 21 additional studies. Ultimately, 44 studies were included in the final review corpus for content analysis and thematic coding to identify the major AI approaches in higher education (Page *et al.*, 2021 [29]; Khalil *et al.*, 2024 [20]; Hou, 2025 [16]).

2.4 Thematic Coding and Classification

Following the Axial Coding process, the 44 selected studies were organized into 10 thematic categories representing the major research themes of AI in higher education (Table 2). Subsequently, through Selective Coding, conceptually related themes were consolidated into six overarching AI approaches based on three criteria: (i) shared research objectives, (ii) conceptual similarity, and (iii) their relevance to AI-integrated teaching management (Bond *et al.*, 2024 [4]; Khalil *et al.*, 2024 [20]; Hou, 2025 [16]; Liew *et al.*, 2024 [22]; Zawacki-Richter *et al.*, 2019 [47]).

Accordingly, the 10 thematic categories presented in Table 2 represent the outcomes of the Axial Coding process, whereas the six AI approaches summarized in Table 2a are the results of Selective Coding. This synthesis transformed fragmented research themes into a coherent conceptual structure, providing the theoretical foundation for the development of the AI-Integrated Teaching Management Framework (AI-ITMF) (Page *et al.*, 2021 [29]; Khalil *et al.*, 2024 [20]; Liew *et al.*, 2024 [22]).

Table 2: Thematic Categories Identified from the 44 Selected Studies on AI in Higher Education

Sources	**Axial Coding (Thematic Categories)**	**Selective Coding (Final AI Approaches)**	**Research Focus**	**Relevance to AI-Integrated Teaching Management**
Siemens & Long (2011); Ifenthaler & Yau (2020); Khalil *et al.* (2024); Chu *et al.* (2022)	Learning Analytics; Educational Data; Evidence-based Decision-Making	1. Learning Analytics and Educational Data	Leveraging learning data to support educational management and quality enhancement	•

Crompton & Burke (2023); Fütterer *et al.* (2024); Hou (2025); Neumann *et al.* (2026); Shailendra *et al.* (2024)	AI Adoption; AI Integration; Institutional Adoption	2. AI Adoption and Implementation	AI adoption models and implementation conditions in higher education	●
UNESCO (2021, 2023); McDonald *et al.* (2024); Bacalso *et al.* (2026); Wu *et al.* (2024)	AI Governance; AI Ethics; Institutional Policy	3. AI Governance and AI Ethics	Policies, governance mechanisms, and responsible AI implementation	●
García-Peñalvo (2023); Katsamakas *et al.* (2024); Sánchez-Prieto *et al.* (2024); Liew *et al.* (2024); OECD (2021)	Smart University; Digital Transformation; Systems Thinking	4. Smart Universities and Digital Transformation	Developing AI-enabled digital ecosystems and institutional infrastructure	○
Southworth *et al.* (2023); Mah & Groß (2024); Selwyn *et al.* (2023); Daniel (2024)	AI Literacy; Faculty Development; AI Capability	5. AI Literacy and Capacity Development	Developing AI competencies for faculty, students, and institutional leaders	○
Zawacki-Richter *et al.* (2019); Ouyang *et al.* (2022); Holmes *et al.* (2019); Williamson & Eynon (2020)	AI in Teaching; Curriculum Integration; AI Across the Curriculum; Pedagogy	6. AI Integration into Curriculum and Teaching	Integrating AI into curricula, teaching practices, and pedagogical innovation	●
Holmes *et al.* (2019); Williamson & Eynon (2020); Chu *et al.* (2022); Crompton & Burke (2023)	AI in Higher Education; Future of Teaching	7. AI in Higher Education	Examining emerging trends in AI-enabled higher education	○
UNESCO (2023); McDonald *et al.* (2024); Shailendra *et al.* (2024); Bacalso *et al.* (2026)	Generative AI; Responsible AI	8. Generative AI in Higher Education	Applications and governance of generative AI in higher education	●
Daniel (2024); McDonald *et al.* (2024); Wu *et al.*	Institutional Leadership; AI	9. AI Leadership, Policy, and	Institutional leadership, AI readiness, and	●

(2024); UNESCO (2021)	Readiness; AI Policy	Institutional Readiness	implementation strategies	
Liew *et al.* (2024); Katsamakas *et al.* (2024); Rojas & Chiappe (2024); García-Peñalvo (2023)	Systems Thinking; AI Ecosystem; Educational Innovation	10. Systems Thinking and AI Ecosystems in Higher Education	Developing AI-enabled educational ecosystems from a systems perspective	○

Note: ● = directly related to AI-integrated teaching management or teaching management activities.
○ = indirectly related through AI governance, institutional policy, curriculum development, or higher education systems.
Source: Compiled and coded by the author from the 44 studies selected following the PRISMA 2020 review procedure (Page *et al.*, 2021 [29]).

Following full-text review and Open Coding, conceptually similar codes were grouped through Axial Coding into ten thematic categories. Subsequently, Selective Coding was employed to synthesize these categories into six overarching AI approaches (Table 2a). Specifically, the themes AI in Higher Education, Generative AI, Institutional Leadership & AI Policy, and Systems Thinking & AI Ecosystem were integrated into the six final approaches according to their conceptual relationships and research objectives. This synthesis established the theoretical foundation for the development of the AI-Integrated Teaching Management Framework (AI-ITMF) (García-Peñalvo, 2023 [14]; Katsamakas *et al.*, 2024 [19]; Wu *et al.*, 2024 [46]).

Table 2a: Synthesis of Ten Thematic Categories into Six AI Approaches

Thematic Categories (Axial Coding)	**Final AI Approaches (Selective Coding)**
Learning Analytics	(1) Learning Analytics and Educational Data
AI Adoption	(2) AI Adoption and Implementation
AI Governance & Ethics	(3) AI Governance and AI Ethics
Smart University	(4) Smart Universities and Digital Transformation
AI Literacy	(5) AI Literacy and Capacity Development
AI Across the Curriculum	(6) AI Integration into Curriculum and Teaching
AI in Higher Education	(6) AI Integration into Curriculum and Teaching
Generative AI	(6) AI Integration into Curriculum and Teaching *(also contributing to AI Governance)*
Institutional Leadership & AI Policy	(3) AI Governance and AI Ethics *(also supporting AI Adoption)*
Systems Thinking & AI Ecosystem	(4) Smart Universities and Digital Transformation *(providing the systems foundation for AI-ITMF)*

Source: Developed by the author based on thematic coding and synthesis of the 44 studies selected through the PRISMA 2020 review process (Page *et al.*, 2021) [29]

3. Results

3.1 Major AI Approaches in Higher Education

3.1.1 Learning Analytics and Data-Driven Decision-Making

Learning Analytics represents one of the earliest AI-related research approaches in higher education, focusing on the use of educational data to support institutional decision-making and improve teaching and learning quality. Seminal studies by Siemens and Long (2011) [40], Ifenthaler and Yau (2020) [17], Chu *et al.* (2022) [7], and Khalil *et al.* (2024) [20] demonstrate the evolution of Learning Analytics from analyzing learning behaviors to predictive analytics, educational data governance, and evidence-based decision-making.

As summarized in Table 2, this approach encompasses Learning Analytics, educational data, early warning systems, and data-driven decision-making. While these studies establish an important foundation for data-driven teaching management, they primarily focus on learning data analysis rather than integrating educational data, AI governance, and the entire teaching management process within a unified framework. This gap provides an important rationale for developing the AI-ITMF.

3.1.2 AI Adoption Framework

The AI Adoption approach originated from technology acceptance theories, such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), and has subsequently evolved toward institutional AI implementation in higher education. Representative studies by Crompton and Burke (2023) [8], Fütterer *et al.* (2024) [13], Hou (2025) [16], Neumann *et al.* (2026) [26], and Shailendra *et al.* (2024) [39] identify the key conditions for successful AI implementation, including institutional readiness, digital infrastructure, data resources, human capacity, and supporting policies.

According to the thematic coding results presented in Table 2, this approach comprises AI adoption, AI integration, AI readiness, and AI implementation pathways, highlighting the institutional requirements and implementation processes for AI adoption in higher education. However, existing studies primarily emphasize implementation readiness, whereas the management, monitoring, and continuous improvement of teaching activities after AI adoption remain insufficiently addressed. These findings indicate the need for a framework extending beyond AI implementation toward continuous teaching improvement.

3.1.3 AI Governance and AI Ethics

This approach focuses on establishing governance mechanisms that ensure the transparent, trustworthy, and responsible use of AI in higher education. Representative studies by UNESCO (2021, 2023) [43,44], McDonald *et al.* (2024) [25], Wu *et al.* (2024) [46], and Bacalso *et al.* (2026) [2] emphasize the importance of institutional policies, data governance, AI ethics, and accountability in governing AI-enabled higher education.

As shown in Table 2, this approach includes AI Governance, AI Ethics, Responsible AI, data governance, and institutional policy. Although the existing literature provides comprehensive governance principles at the institutional level, it has not yet systematically linked AI governance to the entire teaching management process. Accordingly, AI governance is incorporated into the AI-ITMF as a foundational governance mechanism.

3.1.4 Smart Universities and Digital Transformation

This approach has emerged from the digital transformation of higher education, in which AI is regarded as a core enabling infrastructure for institutional governance, teaching innovation, and the development of smart university ecosystems. Studies by García-Peñalvo (2023) [14], Katsamakas *et al.* (2024) [19], Sánchez-Prieto *et al.* (2024) [37], Liew *et al.* (2024) [22], and OECD (2021) [27] conceptualize smart universities through the integration of AI, educational data, and systems thinking to enhance institutional effectiveness.

As indicated in Table 2, this approach emphasizes digital transformation strategies, AI infrastructure, and smart university ecosystems. However, the existing literature primarily addresses institutional transformation and provides limited explanation of how digital infrastructure, educational data, and AI-integrated teaching management can be systematically connected. This systems perspective informs the architectural design of the AI-ITMF.

3.1.5 AI Literacy and Capacity Development

This approach highlights the development of AI competencies among faculty members, students, and educational leaders to enable the effective and responsible use of AI in higher education. Representative studies by Southworth *et al.* (2023) [41], Mah and Groß (2024) [24], Selwyn *et al.* (2023) [38], and Daniel (2024) [10] identify AI literacy as a core competency while extending the discussion to digital capability, professional development, and the responsible use of AI in teaching and educational management.

According to the thematic coding results presented in Table 2, this approach focuses on AI literacy, AI capability, faculty development, and AI capacity building. Although existing studies have proposed competency frameworks and professional development models, they have paid limited attention to integrating AI capability development throughout the entire teaching management process. Accordingly, the AI-ITMF embeds AI capability development within the planning, implementation, assessment, and continuous improvement of teaching and learning.

3.1.6 AI Integration into Curriculum and Teaching

This approach focuses on embedding AI across curricula and teaching practices to develop learners' AI competencies and promote innovation in higher education. Foundational studies by Zawacki-Richter *et al.* (2019) [47], Holmes *et al.* (2019) [15], Ouyang *et al.* (2022) [28], and Williamson and Eynon (2020) [45] have advanced the

integration of AI into curriculum design, instructional practices, assessment, and the broader concept of AI Across the Curriculum.

As summarized in Table 2, this approach encompasses AI in Teaching, Curriculum Integration, AI Across the Curriculum, and pedagogical innovation, representing the AI approach most directly associated with AI-integrated teaching management. Nevertheless, current studies have not established a comprehensive management framework that systematically connects curriculum design, faculty development, educational data governance, quality assurance, and continuous improvement. Together, these limitations directly motivate the development of the AI-ITMF proposed in this study.

3.2 Development Trends, Interrelationships, and Research Gaps of AI Approaches in Higher Education

3.2.1 Frequency of AI Approaches Identified in the 44 Reviewed Studies (Quantitative Analysis)

Based on the coding results presented in Table 2, descriptive statistics were employed to determine the frequency of occurrence of the six AI approaches identified across the 44 selected studies. Because a single study could be coded into more than one thematic category, the cumulative percentages exceed 100%, which is consistent with the characteristics of systematic literature reviews using thematic coding.

Table 3: Frequency of the Six AI Approaches Identified in the 44 Reviewed Studies

AI Approach	Number of Studies (n)	Percentage (%)
(1) Learning Analytics and Data-driven Decision Making	14	31.1
(2) AI Adoption and Implementation in Higher Education	16	35.6
(3) AI Governance and AI Ethics	12	26.7
(4) Smart University and Digital Transformation	10	22.2
(5) AI Literacy and AI Capability Development	8	17.8
(6) AI Integration into Curriculum and Teaching Practices	11	24.4

The results in Table 3 indicate that AI Adoption and Implementation (35.6%) and Learning Analytics and Data-driven Decision Making (31.1%) are the two most frequently addressed approaches in the reviewed literature. AI Governance and AI Ethics, AI Integration Across the Curriculum, and Smart University and Digital Transformation exhibit relatively similar frequencies (22.2-26.7%), reflecting a growing shift from AI applications in teaching and learning toward institutional governance and digital transformation in higher education. In contrast, AI Literacy and AI Capability Development show the lowest frequency (17.8%), suggesting that this area remains comparatively underexplored and warrants further investigation.

Overall, these findings reveal a clear evolution in AI research within higher education - from technology-oriented applications toward the adoption, governance, and system-level integration of AI, highlighting an increasingly holistic and systems-oriented perspective.

3.2.2 Interrelationships among the Six AI Approaches (Qualitative Analysis)

The synthesis of the 44 selected studies indicates that the six AI approaches in higher education have not evolved independently; rather, they have developed through a cumulative and complementary progression, as illustrated in Table 4. The analysis reveals a logical developmental sequence comprising: (1) Learning Analytics and educational data → (2) AI adoption and implementation → (3) AI governance and ethics → (4) Smart University and digital transformation → (5) AI literacy and capability development → (6) AI integration into curriculum and teaching practices (Ifenthaler & Yau, 2020 [17]; Hou, 2025 [16]; Liew *et al.*, 2024 [22]; Mah & Groß, 2024 [24]; Ouyang *et al.*, 2022 [28]).

Rather than representing isolated research streams, these approaches progressively build upon one another, expanding the scope of AI research from classroom-level applications to institutional governance and digital transformation in higher education. Their interrelationships demonstrate that educational data, AI governance, digital infrastructure, AI capability, and teaching and learning activities function as interdependent components within an integrated educational ecosystem. This conceptual progression provides the theoretical foundation for the proposed AI-Integrated Teaching Management Framework (AI-ITMF), which unifies these previously fragmented perspectives into a comprehensive systems-based framework for AI-integrated teaching management in higher education (Katsamakas *et al.*, 2024 [19]; Liew *et al.*, 2024 [22]; García-Peñalvo, 2023 [14]; UNESCO, 2023 [44]).

3.2.3 Research Gaps in Current AI Approaches in Higher Education

3.2.3.1 Theoretical Integration

Existing AI approaches-including Learning Analytics, AI Adoption, AI Governance, Smart University, AI Literacy, and AI Across Curriculum-have largely evolved independently, each focusing on a specific dimension of AI in higher education. Although these approaches have made important theoretical contributions, current studies have not established a unified conceptual framework that systematically integrates governance, data, AI technologies, and teaching activities into a coherent management system (Chu *et al.*, 2022 [7]; Daniel, 2024 [10]; Khalil *et al.*, 2024 [20]; Liew *et al.*, 2024 [22]; Neumann *et al.*, 2026 [26]).

3.2.3.2 Teaching Management Perspective

Most existing studies regard AI primarily as a tool to support teaching or learning. However, AI-integrated teaching management-from curriculum design and instructional delivery to assessment and data-driven quality improvement-has rarely been conceptualized as an integrated management system (Fütterer *et al.*, 2024 [13]; Hou, 2025 [16]; Khalil *et al.*, 2024 [20]; McDonald *et al.*, 2024 [25]; Mah & Groß, 2024 [24]).

3.2.3.3 Integrated Management Framework

To date, no existing framework has systematically integrated the core components of teaching management with AI Governance, Learning Analytics, and a Data Feedback Loop within a unified conceptual model. Addressing this research gap, the present study proposes the AI-Integrated Teaching Management Framework (AI-ITMF) based on a systems-thinking approach. The framework connects the six core components of teaching management through a Data Feedback Loop, enabling data-driven teaching governance and continuous quality improvement (Katsamakas *et al.*, 2024 [19]; Khalil *et al.*, 2024 [20]; Rojas & Chiappe, 2024 [35]; Liew *et al.*, 2024 [22]; Ouyang *et al.*, 2022 [28]).

3.3 Proposed AI-Integrated Teaching Management Framework (AI-ITMF) for Higher Education

3.3.1 Structure of the AI-ITMF

The AI-Integrated Teaching Management Framework (AI-ITMF) is designed to address three fundamental questions:

1) What is managed?
2) What management activities are performed, and what feedback data are generated?
3) Who are the responsible stakeholders, and how does AI support them?

The proposed framework is presented in Table 4.

Table 4: AI-Integrated Teaching Management Framework (AI-ITMF) for Higher Education

AI-ITMF Component	**Core Management Functions and Feedback Data**	**Stakeholders and AI Support**
1. AI-integrated learning outcomes, graduate attributes, and curriculum	• Define graduate learning outcomes and AI competencies; • Develop, review, and update curricula; • Align graduate attributes with professional competencies; • Promote career orientation and digital competencies; **Feedback data:** learning outcomes, labor market needs, learning performance, employer feedback, and student feedback.	University leaders, Academic Affairs Office, Faculties/Departments, Academic Council. AI supports workforce demand analysis, curriculum benchmarking, skills forecasting, and curriculum recommendations.
2. AI-integrated teaching content and learning resources	• Design AI-integrated disciplinary content;	Faculties/Departments, lecturers, IT Center, Digital Library. AI supports content generation, resource recommendation, content personalization, and digital knowledge management.

	• Develop digital, AI-based, and generative AI learning resources; • Manage open educational resources (OER); • Integrate AI ethics and responsible AI use; **Feedback data:** resource utilization, student feedback, and learning resource effectiveness.	
3. Teaching activities of lecturers	• Design courses and teaching plans; • Deliver AI-integrated instruction; • Apply Learning Analytics; • Improve teaching based on learning data; **Feedback data:** learner participation, learning progress, learning outcomes, and student feedback.	Lecturers, academic departments, faculties, IT Center.AI supports instructional design, virtual teaching assistants, classroom analytics, early warning systems, and instructional decision support.
4. Student learning activities	• Develop personalized learning plans; • Learn with Intelligent Tutoring Systems (ITS) and AI assistants; • Monitor learning progress; • Develop self-directed learning and AI competencies; **Feedback data:** learning progress, learner engagement, competency attainment, and digital learning portfolios.	Students, academic advisors, lecturers. AI supports personalized learning pathways, academic advising, risk alerts, and self-directed learning.
5. Assessment and learning feedback	• Design AI-appropriate assessment; • Conduct formative and summative assessment; • Analyze assessment results and provide automated feedback; • Ensure academic integrity;	Lecturers, academic departments, Assessment Center, Quality Assurance Office. AI supports automated grading, learning analytics, anomaly detection, automated feedback, and academic integrity monitoring.

	• Manage digital learning portfolios. **Feedback data:** assessment results, competency evidence, learning feedback, and quality assurance data.	
6. Quality assurance conditions for AI-integrated teaching	• AI policy and governance; • Digital infrastructure and AI platforms; • Data systems and data governance; • Faculty digital capability development; • AI ethics, data security, and privacy; • Quality assurance and continuous improvement **Feedback data:** quality indicators, AI utilization, system performance, and improvement outcomes.	University leaders, Academic Affairs Office, IT Center, Quality Assurance Office, Faculties/Departments. AI supports system monitoring, integrated analytics, management dashboards, predictive analytics, and managerial decision support.

Source: Proposed by the author based on the synthesis of AI approaches in higher education.

The AI-Integrated Teaching Management Framework (AI-ITMF) was developed through the systematic synthesis, coding, and mapping of six major AI approaches identified from 44 studies following the PRISMA 2020 protocol onto teaching management functions grounded in Systems Theory. This process resulted in six core management components that collectively constitute the proposed framework (Page *et al.*, 2021 [30]; García-Peñalvo, 2023 [14]; Katsamakas *et al.*, 2024 [19]; Liew *et al.*, 2024 [22]).

The novelty of AI-ITMF does not lie in introducing new management components, but rather in integrating curriculum objectives, instructional content, teaching, learning, assessment, and quality assurance through a Data Feedback Loop. This mechanism enables continuous data collection, analysis, and feedback within the PDCA (Plan-Do-Check-Act) cycle, thereby supporting evidence-based decision-making and continuous quality improvement (Katsamakas *et al.*, 2024 [19]; UNESCO, 2023 [44]; McDonald *et al.*, 2024 [25]).

3.3.2 Data Feedback Loop in the AI-ITMF

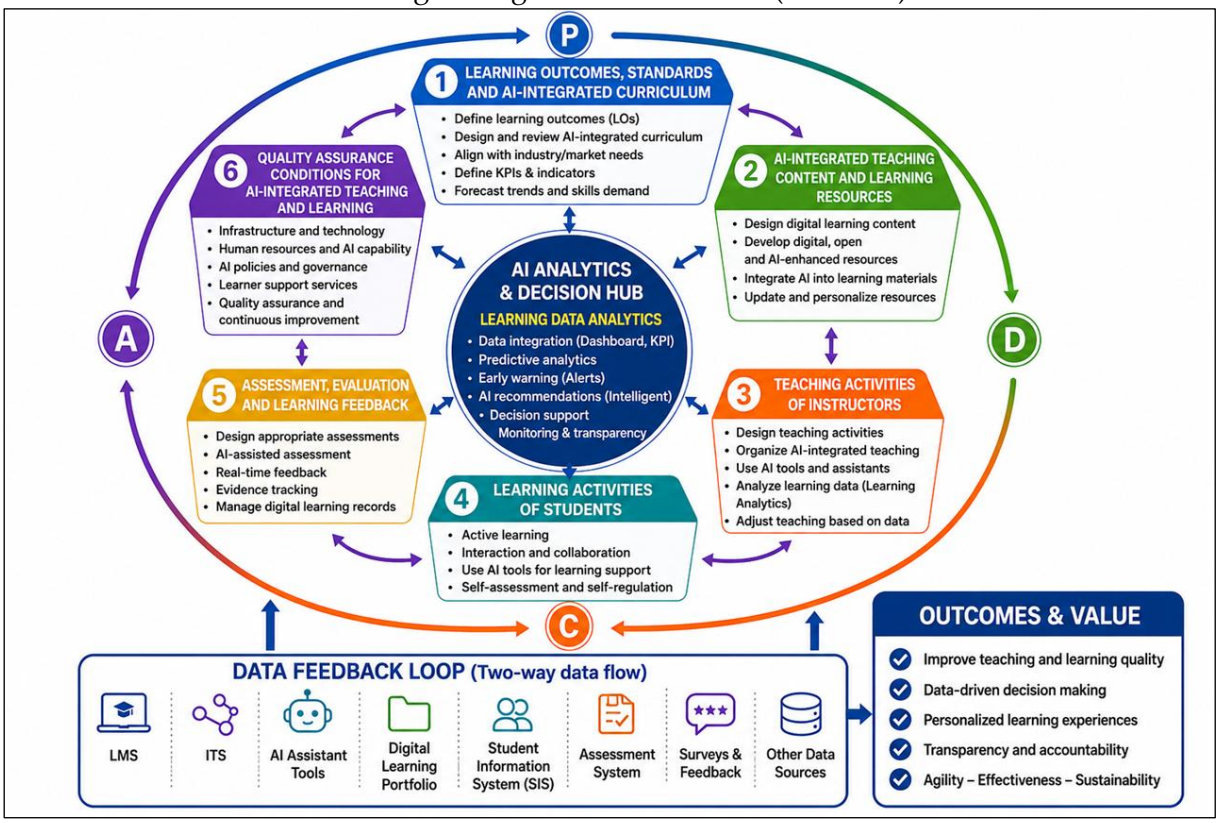
The Data Feedback Loop is the central operational mechanism of the proposed AI-Integrated Teaching Management Framework (AI-ITMF). It connects the six teaching management components into an integrated system, ensuring that management decisions are continuously informed by data and refined through evidence-based improvement (Figure 2). The framework is grounded in three complementary theoretical foundations: Learning Analytics, AI Governance, and Systems Thinking, which

collectively constitute the conceptual foundation and novelty of AI-ITMF (Siemens & Long, 2011 [40]; Khalil *et al.*, 2024 [20]; Katsamakas *et al.*, 2024 [19]).

Unlike existing frameworks that primarily emphasize learning analytics or AI implementation, AI-ITMF integrates Learning Analytics, AI Governance, and Systems Thinking into a unified teaching management mechanism supported by a continuous PDCA cycle. Rather than functioning solely as a data analysis tool, the Data Feedback Loop enables continuous monitoring, analysis, decision support, and quality improvement across the entire teaching management process.

As illustrated in Figure 2, the framework consists of three interconnected layers. The outer layer represents the PDCA cycle, which supports continuous improvement through ongoing monitoring, KPI measurement, data analysis, managerial decision-making, and quality enhancement.

Figure 2: Data Feedback Loop in the AI-Integrated Teaching Management Framework (AI-ITMF)



Source: Proposed by the author based on the synthesis of AI approaches in higher education and adapted from the Data Feedback Loop concept of Katsamakas *et al.* (2024) [19].

The management layer comprises the six core components of AI-ITMF: (1) learning outcomes and curriculum, (2) teaching content and learning resources, (3) teaching activities, (4) student learning activities, (5) assessment and learning feedback, and (6) quality assurance conditions. Each component exchanges data bidirectionally with the AI Analytics and Decision Hub, creating a continuous feedback mechanism that supports evidence-based refinement of curriculum, instruction, assessment, and quality assurance.

At the center of the framework, the AI Analytics and Decision Hub integrate data from learning management systems (LMS), intelligent tutoring systems (ITS), AI assistants, digital learning portfolios, student information systems (SIS), assessment platforms, and other institutional data sources. It performs learning analytics, predictive analytics, KPI monitoring, early-warning detection, and AI-assisted decision support, transforming educational data into actionable management intelligence.

The principal innovation of AI-ITMF lies in extending the role of Learning Analytics beyond learning performance analysis toward comprehensive teaching management decision support. By integrating AI Governance and the Data Feedback Loop within a systems-based PDCA framework, AI-ITMF provides a unified mechanism for adaptive, transparent, and continuously improving teaching management in higher education.

3.4 Discussion, Theoretical Contributions, Practical Implications, Limitations, and Future Research

The findings of this systematic literature review indicate that research on artificial intelligence (AI) in higher education has evolved from discrete approaches-such as Learning Analytics, AI Adoption, AI Governance, Smart University, and AI Literacy-toward a more integrated perspective that emphasizes AI-supported teaching management and digital transformation. However, as summarized in Table 5, existing frameworks primarily address individual dimensions of AI implementation and have yet to integrate AI governance, learning analytics, and data feedback mechanisms into a unified teaching management framework [17], [25], [44].

Table 5: Comparison of the Scope and Contributions of AI-ITMF with Existing AI Frameworks in Higher Education

Framework / Approach	Primary Focus	Research Gap	Contribution of AI-ITMF (Novel Contribution)
Learning Analytics	Learning data analytics, dashboards, predictive analytics	Focuses primarily on learning data without connecting the entire teaching management process	Extends Learning Analytics into a decision-support mechanism covering all six teaching management components through the Data Feedback Loop
AI Adoption Framework	Conditions for AI implementation	Emphasizes implementation readiness rather than ongoing management	Extends AI adoption from implementation to the management, monitoring, and continuous improvement of AI-integrated teaching
AI Governance	AI policies, ethics, and governance	Not explicitly connected to teaching and learning processes	Integrates AI Governance as the coordinating foundation for data governance, institutional policies, and decision support across the entire management framework

Smart University	Digital ecosystem and institutional transformation	Primarily focuses on institutional governance	Connects digital infrastructure with teaching management processes through a continuous data feedback mechanism
AI Literacy & AI Across Curriculum	AI competency development	Limited integration with quality management	Links AI competency development with curriculum design, teaching activities, assessment, and continuous quality improvement
AI-ITMF	Integrated AI-supported teaching management framework	Requires empirical validation	Integrates six teaching management components with AI Governance, Learning Analytics, and the Data Feedback Loop into a unified management framework operating through the PDCA cycle

Source: Compiled by the author based on the synthesis of 44 selected studies.

The findings demonstrate that AI-ITMF builds upon the strengths of existing AI frameworks while extending them through a systems perspective. Overall, AI-ITMF contributes to the literature by bridging the gap between AI technologies and teaching management. Unlike previous frameworks that emphasize isolated dimensions of AI adoption, governance, or learning analytics, AI-ITMF integrates these perspectives into a coherent systems-based framework supported by continuous data feedback and the PDCA cycle. This integration provides both a theoretical foundation and a practical reference for implementing responsible, data-driven, and sustainable AI in higher education.

3.4.1 Theoretical Contributions

This study makes three primary theoretical contributions.

First, it proposes the AI-Integrated Teaching Management Framework (AI-ITMF) as a conceptual framework that integrates the major AI approaches in higher education into a unified teaching management model.

Second, it extends the Context-Input-Process-Output (CIPO) model by incorporating AI Governance, Learning Analytics, and the Data Feedback Loop as key mechanisms linking data, governance, and teaching activities within a systems-based management framework.

Third, it broadens the role of Learning Analytics beyond learning data analysis by positioning it as a decision-support mechanism for the entire teaching management process, thereby enabling evidence-based management and continuous quality improvement.

3.4.2 Practical Implications

AI-ITMF provides a practical reference framework for higher education institutions to formulate AI implementation strategies, establish data-driven teaching management systems, and promote continuous quality improvement through the PDCA cycle.

Table 6: Coverage Comparison between AI-ITMF and Representative AI Frameworks in Higher Education (✓/X)

Framework	Curriculum	Teaching	Learning	Assessment	Quality Assurance	Feedback
Learning Analytics	x	✓	✓	✓	x	✓
AI Adoption	x	x	x	x	✓	x
AI Governance	x	x	x	x	✓	x
Smart University	x	x	x	x	✓	x
AI Literacy	✓	✓	✓	x	x	x
AI-ITMF	✓	✓	✓	✓	✓	✓

Source: Compiled by the author based on the synthesis of representative AI frameworks in higher education.

The framework can support institutional leaders in strategic planning; academic units in curriculum design, learning resource development, and assessment; instructors in redesigning teaching practices; and quality assurance offices in developing monitoring systems and key performance indicators (KPIs).

As shown in Table 6, AI-ITMF is the only framework that simultaneously covers all six core components of teaching management.

4. Limitations

This study has three main limitations.

First, AI-ITMF was developed through a synthesis of 44 international studies and has not yet been empirically validated using real-world institutional data.

Second, the findings are inherently constrained by the scope of the literature reviewed, the inclusion criteria, and the thematic coding procedures adopted in the systematic literature review, although the review strictly followed the PRISMA 2020 guidelines.

Third, AI-ITMF currently remains a conceptual framework. The relationships among its components and its applicability across diverse higher education contexts have yet to be empirically examined.

4.1 Future Research

To further refine and validate AI-ITMF, this study proposes a five-stage research agenda:

1) Develop and refine the conceptual framework;
2) Empirically validate the framework using Delphi, Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM);
3) Develop a comprehensive set of standards and performance indicators;
4) Establish an AI-ITMF Maturity Model;
5) Develop an integrated indicator system and AI-supported decision-support platform.

This research agenda is expected to facilitate the transition of AI-ITMF from a conceptual framework to an operational teaching management model that can be effectively implemented in higher education institutions.

Overall, AI-ITMF advances the current literature by integrating AI Governance, Learning Analytics, Systems Thinking, and the Data Feedback Loop into a unified teaching management framework. By connecting curriculum, teaching, learning, assessment, and quality assurance through continuous data feedback, the framework provides both a theoretical foundation and a practical roadmap for implementing responsible, evidence-based, and sustainable AI in higher education.

5. Conclusion

Based on a systematic review of 44 studies on artificial intelligence (AI) in higher education published between 2011 and 2026, this study identified and synthesized six major AI approaches, revealing a clear evolution in the literature from AI applications in teaching and learning toward AI governance and the development of smart university ecosystems. Building upon this synthesis and the identified research gaps, the study proposes the AI-Integrated Teaching Management Framework (AI-ITMF) as a systems-based conceptual framework for AI-integrated teaching management in higher education.

The proposed AI-ITMF consists of six core teaching management components interconnected through a Data Feedback Loop, enabling data-driven teaching management and continuous quality improvement based on the PDCA cycle. The principal contribution of this study does not lie in introducing new management components, but rather in integrating previously fragmented AI approaches into a unified conceptual framework that provides a comprehensive theoretical foundation for AI-integrated teaching management in contemporary higher education.

As AI-ITMF remains a conceptual framework, further research is required to validate its structure and applicability through Delphi studies, Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM). Future studies should also develop a comprehensive standards framework, an AI-ITMF Maturity Model, and an AI-supported decision-support system to enhance the framework's practical implementation and effectiveness across diverse higher education contexts.

Conflict of Interest Statement

The authors declare that there are no financial, personal, or professional conflicts of interest that could have influenced the research, analysis, interpretation of findings, or publication of this article.

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