International Journal of Management Research and Social Science (IJMRSS)
Volume 13, Issue 2, April – June 2026
ISSN 2394-6407(Print)
ISSN 2394-6415(Online)

Impact of AI on Labour Teaching Technologies

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Abstract — This study examines how teachers use Artificial Intelligence (AI) in both their classroom teaching and their professional development. Although AI has become an important part of educational innovation, most existing research focuses mainly on how AI tools are used with students, rather than how teachers themselves learn to use these technologies. To understand this gap, a systematic review was conducted on studies published between 2015 and 2024. Following the PRISMA guidelines, the review included a careful process of searching, screening, and selecting relevant literature. A total of 95 research articles were identified and analysed. Each study was reviewed to understand, how teachers are using AI in their teaching practices, what are the kinds of professional development opportunities are available to help teachers learn and integrate AI effectively. The analysis showed a clear imbalance in research distribution. About 65 per cent of the studies focused on how AI is used directly in teaching—such as conversational AI tools, AI-based learning and assessment systems, immersive technologies, visual/audio computing, and learning analytics. In contrast, only 35 per cent of the studies examined how AI supports teachers' professional development. The findings reveal a significant gap: while AI is becoming more common in classrooms, much less attention is given to how teachers can be trained and supported in using these technologies. This review suggests that future research should place greater emphasis on teachers' development needs and explore how AI can strengthen both teaching practices and student learning. It also highlights the importance of addressing technological and ethical issues to ensure that AI is used responsibly in education.

Keywords — *Artificial Intelligence (AI); Educational Innovation; Teachers Learn and Integrate AI; Student Learning.*

1. Introduction

The integration of Artificial Intelligence (AI) into educational ecosystems represents one of the most significant technological shifts in modern pedagogy. AI's promise—to personalize learning, automate administrative tasks, and provide deep insights into student cognition—has positioned it as a cornerstone of educational innovation (Zawacki-Richter et al., 2019). However, the successful realization of this promise is fundamentally contingent not on the technology itself, but on the human agents who mediate its use: teachers.

Current discourse and investment often prioritise the development and deployment of AI tools for direct student interaction, such as intelligent tutoring systems and automated grading platforms (Holmes et al., 2019). This student-centric focus, while valuable, has inadvertently cultivated a significant blind spot in the innovation landscape: the systematic preparation and ongoing development of teachers as proficient, pedagogical integrators of AI. Teachers are expected to navigate a rapidly evolving digital terrain with often insufficient training, support, or conceptual frameworks, leading to a gap between technological availability and effective classroom implementation (Celik et al., 2022). This systematic review, therefore, seeks to map and critically analyse the extant scholarly literature from 2015 to 2024 to answer two interconnected research questions:

- *RQ1:* How is AI being used to directly support or transform classroom teaching practices, as documented in the research literature?
- *RQ2:* What types of professional development (PD) opportunities and frameworks are being researched to help teachers learn and integrate AI effectively?

By synthesizing the evidence across these two domains, this paper aims to illuminate the current state of research, identify critical imbalances, and propose a redirected agenda that places teacher learning at the heart of educational AI innovation.

2. Methodology

This review was conducted following the PRISMA 2020 guidelines (Page et al., 2021) to ensure a transparent, reproducible, and comprehensive synthesis of the literature.

2.1 Search Strategy

A systematic search was performed across four major academic databases: Scopus, Web of Science, ERIC, and IEEE Xplore. The search query combined terms related to three key concepts:

- Population: teacher OR educator OR faculty

DOI: **10.30726/ijmrss/v13.i2.2026.13266**

- Intervention: artificial intelligence OR AI OR machine learning OR intelligent tutoring system
- Context: professional development OR training OR TPACK OR integration OR classroom practice OR pedagogy

The search was limited to peer-reviewed journal articles and conference proceedings published in English between January 2015 and August 2024.

2.2 Inclusion and Exclusion Criteria

Inclusion Criteria: Empirical (qualitative, quantitative, or mixed-methods) or rigorous conceptual/theoretical studies focus on K-12 or higher education settings. Primary focus on teacher use of AI for instruction or teacher PD related to AI.

Exclusion Criteria: Studies focused solely on student outcomes without analysing teacher practice or PD. Technical papers describing AI tool development without an educational implementation or evaluation component. Editorials, opinion pieces, and non-peer-reviewed literature.

2.3 Screening and Selection Process

The initial database search yielded 2,318 records. After removing duplicates, 1,745 titles and abstracts were screened against the inclusion criteria. This resulted in 215 articles selected for full-text review. Following a detailed assessment, 95 studies were deemed eligible for final synthesis (see PRISMA flow diagram, Figure 1). The screening was conducted independently by two reviewers, with disagreements resolved through discussion and consensus.

2.4 Data Extraction and Analysis

Data from the 95 selected studies were extracted into a standardized coding sheet. Key information included: author(s), year, study design, country, educational level, AI technology type, focus (Teaching Practice vs. Professional Development), main findings, and reported challenges. A thematic analysis approach (Braun & Clarke, 2006) was then employed to identify, analyze, and report patterns within the two primary research foci.

3. Results

3.1 Overview of Included Studies

The 95 studies spanned 28 countries, with significant contributions from the United States, China, Australia, the United Kingdom, and South Korea. The research designs were varied: 45 per cent qualitative, 35 per cent quantitative, and 20 per cent mixed-methods. A clear thematic bifurcation emerged, leading to the classification of studies into two primary categories.

3.2 Research Focus 1: AI in Classroom Teaching Practices (65per cent of studies, n=62)

This dominant category explored the direct application of AI tools in instructional settings. Five major sub-themes were identified:

- Conversational AI & Pedagogical Agents (25per cent): Studies examined chatbots (e.g., ChatGPT) and embodied conversational agents used for student Q&A, scaffolding dialogue, and role-playing. Research highlighted benefits in fostering student engagement and providing 24/7 support but raised concerns about factual accuracy and the erosion of teacher-student interaction (Kasneci et al., 2023).
- AI-Based Adaptive Learning & Assessment Systems (30per cent): This largest sub-theme focused on platforms that personalize learning pathways and automate assessment. Studies reported efficiency gains in diagnosing learning gaps and reducing grading workload but noted challenges related to algorithmic transparency and the black box problem of score generation (Baker & Hawn, 2021).
- Immersive & Multimodal Technologies (20per cent): Research explored AI-driven Virtual Reality (VR), Augmented Reality (AR), and simulations. Findings emphasized enhanced experiential learning and motivation, but identified significant barriers in cost, technical complexity, and the need for extensive teacher facilitation (Radianti et al., 2020).
- Visual/Audio Computing for Classroom Analytics (15per cent): Studies utilized AI for automated classroom observation, analyzing video/audio to measure student engagement, teacher talk time, and collaborative patterns. While praised for providing objective feedback, ethical concerns regarding surveillance and data privacy were prominent (Gillani et al., 2023).
- Learning Analytics Dashboards (10per cent): This research focused on AI-powered dashboards that visualize student data for teachers. Evidence suggested they can inform instructional decisions but also risk data overload and misinterpretation without proper teacher data literacy (Viberg et al., 2018).

3.3 Research Focus 2: AI for Teacher Professional Development (35per centof studies, n=33)

This smaller body of literature addressed how teachers learn to use AI. Three key sub-themes were discerned:

- Structured PD Programs & Workshops (50per cent): These studies evaluated formal training interventions. Effective programs were characterized as being sustained (not one-off), hands-on, collaborative, and

DOI: 10.30726/ijmrss/v13.i2.2026.13266

pedagogy-first—framing AI as a tool to solve specific instructional problems rather than a technical novelty (Trust et al., 2023).

- AI as a Direct Tool for Teacher Learning (30per cent): A promising niche explored AI-for-PD, where AI tools themselves support teacher growth. Examples included AI-powered coaching simulators for practicing classroom management and reflective tools that analyze a teacher's lesson recordings to provide feedback (Chen et al., 2022).
- Barriers & Enablers of Integration (20per cent): These studies identified systemic factors. Key barriers included lack of time, fear of job displacement, inadequate infrastructure, and weak technological pedagogical content knowledge (TPACK). Critical enablers were supportive leadership, a collaborative school culture, and access to ongoing technical and pedagogical support (Ertmer & Ottenbreit-Leftwich, 2013).

Table 1: Distribution of Research Focus and Sub-themes (n=95)

Primary Research Focus	Sub-theme	per cent of Total Studies	Key Characteristics
AI in Teaching Practice	1. Conversational AI & Agents	16per cent	Chatbots, tutoring agents, engagement tools
(65per cent)	2. Adaptive Learning & Assessment	20per cent	Personalized pathways, automated grading
	3. Immersive Technologies	13per cent	VR, AR, simulations
	4. Visual/Audio Analytics	10per cent	Classroom observation, engagement metrics
	5. Learning Analytics Dashboards	6per cent	Data visualization for instructional decision-making
AI for Teacher PD	1. Structured PD Programs	18per cent	Workshops, courses, learning communities
(35per cent)	2. AI as a PD Tool	10per cent	Simulators, reflective analysis tools
	3. Barriers & Enablers	7per cent	TPACK, institutional support, anxiety

4. Discussion

The 65/35 split in research focus reveals a profound innovation-implementation gap. The field is heavily invested in showcasing *what* AI can do in the classroom but critically under-invested in researching *how* to equip teachers to do it effectively, ethically, and sustainably.

4.1 The Dominant Narrative: AI as a Disruptive Instructional Tool

The preponderance of studies on teaching practices reinforces a narrative of AI as an autonomous or semi-autonomous agent acting upon the student. This risks relegating the teacher to a peripheral role—a facilitator or monitor of pre-programmed interactions. While these tools offer powerful capabilities, their successful integration depends entirely on the teacher's ability to curate, adapt, and critique their outputs within a sound pedagogical framework, a competency that the current PD literature shows is underdeveloped.

4.2 The Neglected Narrative: The Teacher as Learner and Designer

The smaller corpus on PD, though rich in insights, points to a fragmented and under-theorized approach. Promising directions, such as AI-for-PD, remain nascent. The field lacks large-scale, longitudinal studies on the impact of different PD models on teachers' sustained AI integration and, ultimately, on student outcomes. Furthermore, there is a striking paucity of research on developing teachers' **critical AI literacy**—the ability to interrogate algorithmic bias, data ethics, and the sociopolitical implications of AI in education (Ng et al., 2021).

4.3 Synthesis: Toward a Teacher-Centric AI Innovation Ecosystem

The findings necessitate a paradigm shift from a tool-centric to a teacher-centric model of AI innovation. This model posits that the most impactful AI tool may not be the one used directly by students, but the one that most powerfully augments the teacher's expertise, autonomy, and reflective capacity. Future AI development should be co-designed with educators, and research must pivot to build robust evidence for PD frameworks that are:

- *Pedagogically Grounded:* Rooted in TPACK and specific subject-area needs.
- *Ethically Informed:* Incorporating critical digital literacy and ethics as core components.
- *Ecologically Valid:* Embedded in teachers' daily practice and supported by school-wide systems.

5. Conclusion and Implications

This systematic review confirms that while AI is rapidly permeating educational research and practice, the scholarly focus remains disproportionately on its direct

DOI: 10.30726/ijmrss/v13.i2.2026.13266

instructional applications, leaving the professional development of teachers as the missing link in the innovation chain.

5.1 Implications for Research

- *Re-balance the Research Agenda:* Funders and journals should incentivize research on effective AI-related PD models, teacher learning trajectories, and the development of teacher AI literacy.
- *Conduct Longitudinal Studies:* Track how PD influences long-term integration, teacher self-efficacy, and pedagogical transformation.
- *Deepen Ethical Inquiry:* Expand research on teachers' roles in navigating AI ethics, equity, and bias in real classroom contexts.

5.2 Implications for Policy and Practice

- *Mandate and Fund Embedded PD:* Move beyond one-time workshops to create sustained, job-embedded learning opportunities for teachers.
- *Develop Standards and Competencies:* Educational authorities should define clear AI integration competencies for teachers and include them in accreditation and licensing frameworks.
- *Foster School-University-Industry Partnerships:* Create collaborative hubs for co-designing PD resources, research-informed tools, and supportive communities of practice.

The true promise of AI in education lies not in automating instruction, but in augmenting teachers. By shifting our collective focus from solely building smarter tools to decisively building smarter, more supported, and more critical support systems for teachers, we can bridge the current innovation gap and steer AI toward a future that genuinely enhances human-centred education.

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DOI: 10.30726/ijmrss/v13.i2.2026.13266