International Conference on Ai's Potential To Transform Education and Teacher Practices (ICAETP), 7 Oct, 2025

International Journal of Scientific Research & Engineering Trends
ISSN: 2395-566X

Artificial Intelligence in Teaching and Teacher Professional Development: A Systematic Review

Mr. Rishav Kumar Singh, Mr. Ram Rahul Kumar
Research Scholar (AIU, Manipur, India)

Abstract - The use of Artificial Intelligence (AI) technology in education is considered a major driver of educational innovation. While extensive literature exists on the integration of AI technologies in educational environments, the focus on teachers' roles and their professional development needs remains limited. This study presents a systematic review of research conducted between 2015 and 2024, analyzing how teachers are using AI technology in their teaching and professional development. Specifically, the study focuses on the relationship between the supply of professional development opportunities and the demand for AI integration by teachers. Utilizing PRISMA principles and protocols, this review identified and compiled a total of 95 significant research articles. The findings indicate a disproportionate focus of research. About 65% of the studies centered on the application of AI in teaching, including conversational AI, AI-based learning and assessment systems, immersive technologies, visual and auditory computing, and teaching and learning analytics. In contrast, only 35% of the studies explored the role of AI in teacher professional development. This review highlights the lack of sufficient research on integrating AI technologies into teaching practices, keeping in mind the professional development needs of teachers. It emphasizes the need for future research specifically studying how AI can be used to empower teacher professional development. Moreover, technical and ethical challenges in AI-based professional development should be prioritized to ensure responsible and effective AI integration in education.

Keywords - Artificial Intelligence, AI in Education, Systematic Review, Teaching, Professional Development.

I. INTRODUCTION

Generative Artificial Intelligence (AI) technologies, such as ChatGPT, have rapidly advanced since 2022, showing great potential in transforming education (Bengesi et al., 2024; Lin et al., 2022).

These technologies—like chatbots, AI-assisted learning platforms, and learning analytics tools—enhance teaching by personalizing learning, automating tasks, and providing real-time insights (Tang et al., 2023; Zhang & Aslan, 2021).

However, concerns about reducing teachers' roles and ethical challenges also exist (Chan & Tsi, 2023).Earlier AI applications mainly supported assessment and administration (Wang, 2021), but the rise of large language models now enables creative content generation and complex task support (Creely & Blannin, 2023). While many studies focus on AI's use in teaching, fewer address teachers' professional development and the gap between institutional AI training and practical classroom needs (Chiu et al., 2023; Ng et al., 2023).

The reviews research from 2015 to 2024 to understand how teachers integrate AI into their practice and how professional development evolves. It aims to provide recommendations for aligning AI training with teachers' real needs, helping them effectively use AI in education.

International Journal of Scientific Research & Engineering Trends
ISSN: 2395-566X

II. LITERATURE REVIEW

Since 2022, Generative Artificial Intelligence (AI) technologies, such as ChatGPT, have rapidly matured and demonstrated significant potential across various application domains (Bengesi et al., 2024; Lin et al., 2022). These technological advancements are fueling interest in incorporating advanced AI technologies like Natural Language Processing and Computer Vision into the education sector, establishing AI as a major research area in education (Lo, 2023; Mai et al., 2024). Scholars have extensively explored the role of these AI technologies in enhancing teaching and learning processes through tools like chatbots, AI-assisted learning platforms, data-driven decision support systems, and learning behavior analytics tools (Tang et al., 2023; Zhang & Aslan, 2021).

The potential for AI to innovate education is actively explored.This trend is not without controversies. Concerns have been raised about reducing teachers' roles, affecting educational quality, or negatively impacting students' cognitive development (Chan & Tsi, 2023; Edwards & Cheok, 2018). Nevertheless, the academic community remains focused on exploring potential applications and benefits of AI tools. Before the rise of Generative AI, AI in education was mainly limited to supporting teaching and assessment tasks, such as intelligent learning systems and automatic scoring tools (Wang, 2021). For example, Baker et al. (2019) emphasized the wide use of AI tools in education, serving three major stakeholders – learners, teachers, and academic administrators. Intelligent Learning Systems like CENTURY supported self-paced learning and content personalization based on student preferences. Similarly, ClassCharts software reduced teachers' administrative burdens, offered deep insights into student performance, and encouraged creative classroom practices. Additionally, machine learning-based school evaluation systems supported administrators in decision-making and information management. However, these tools had relatively narrow functionality. Early research suggested that old AI systems were limited in assessing complex cognitive performance and preparing individualized learning content (Zawacki-Richter et al., 2019).

With the rapid advancement of Generative AI technologies, especially applications based on large language models like ChatGPT, unprecedented innovation opportunities have emerged in education. These AI tools not only generate text and images but also handle complex tasks like programming and creative writing (Creely & Blannin, 2023; Denny et al., 2024).

This progress expanded AI applications in education, offering greater flexibility and efficiency in content creation and personalized learning path development. Generative AI techniques enrich the learning experience and enhance teaching efficiency, allowing teachers to focus more on instructional innovation and student engagement (Kshetri, 2023).

In recent years, many scholars have conducted comprehensive reviews of AI applications in education. Ng et al. (2023) analyzed AI's development in teaching and learning research from 2000 to 2020, revealing the widespread adoption of AI tools in university-level computer science education and the growing trend of AI tool integration in K-12 education. They also highlighted the global pace of incorporating AI literacy into academic standards. Chiu et al. (2023) analyzed AI's opportunities, challenges, and future research areas in education. Crompton and Burke (2023) focused on AI applications in higher education between 2016 and 2022, reporting a significant rise in AI usage in 2021 and 2022. Zawacki-Richter et al. (2019) provided a systematic review of AI applications in higher education, focusing on academic support services and institutional administration. Bozkurt et al. (2021) analyzed fifty years of AI research in education, highlighting main themes and serious research gaps concerning ethical issues related to AI in education.

International Journal of Scientific Research & Engineering Trends
ISSN: 2395-566X

However, existing literature primarily focuses on the direct impact of AI technologies on teaching processes, with relatively less attention to the critical role of teachers and their professional development needs. Several studies have identified a significant mismatch between the AI technology training provided by educational institutions and the practical requirements of teachers (Chiu et al., 2023; Ng et al., 2023; Zawacki-Richter et al., 2019).

Since teachers play a central role in academic activities, their proficiency in AI technologies is essential to ensure high-quality teaching. It is therefore critical to understand how teachers practically apply AI technologies and bridge the gap between professional development programs and actual teacher needs. The objective of this study is to develop a comprehensive understanding of what achievements teachers have made in integrating AI technologies into their teaching and how their professional development evolved in this context by systematically reviewing research conducted between 2015 and 2024. This time frame was particularly chosen as it represents a decade of rapid AI progress and its transformative impact on education. The year 2015 marks a pivotal moment in AI development, when techniques such as deep learning and natural language processing began encouraging novel applications in educational contexts (LeCun et al., 2015). During the same period, AI-based educational tools specifically designed for teacher training, professional development, and instructional support also proliferated (Luckin et al., 2016).

Method

This study follows PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to systematically answer the research questions. PRISMA provides a standardized framework for conducting systematic reviews, including steps like literature search, screening, data extraction, analysis, and reporting (Page et al., 2021). The following steps were adopted in this research:

- Conduct a comprehensive literature search based on predefined inclusion and exclusion criteria.
- Perform two rounds of screening to evaluate the eligibility of selected studies.
- Extract key information from the selected studies and organize it into structured tables.
- Perform in-depth analysis of the extracted data to answer research questions.
- Prepare the research report following PRISMA standards.

Search Strategy

This research focuses on literature related to the integration of AI technologies into teaching practices and teacher professional development. A search strategy was developed targeting articles published from January 1, 2015, to July 30, 2024. Initial key terms like "artificial intelligence" and "teachers" were defined. Then, through preliminary review of search results, keywords were refined and expanded to ensure broad coverage. Terms such as "artificial intelligence," "AI," "ChatGPT," "GAI," "Generative AI," along with "teaching," "teacher training," and "teacher professional development" were included.

The search was applied to titles, keywords, and abstracts containing at least one AI-related term and one teaching-professional development-related term.

The literature search was conducted in the Scopus and Web of Science (WoS) databases, recognized for comprehensive coverage of quality journals (Tang et al., 2023; Zhang & Aslan, 2021). The initial search yielded a total of 5623 articles – 792 from Scopus and 4831 from WoS. To ensure quality, only peer-reviewed journal articles were included. Non-empirical articles and conference papers were excluded due to lack of research design and reproducibility (Booth et al., 2021). After this process, 2373 articles were selected for detailed screening.

International Journal of Scientific Research & Engineering Trends
ISSN: 2395-566X

Screening

The screening process was manually conducted with care. First, duplicate articles (485) were identified and removed. Then, remaining articles' titles and abstracts were examined against predefined inclusion and exclusion criteria. As a result, 1696 articles were excluded, including conceptual papers, literature reviews, commentaries, conference papers, etc. Additionally, 23 articles with unavailable full texts were excluded. In the full-text review phase, 74 additional articles did not meet the inclusion criteria. In total, 2278 articles were excluded, and finally, 95 articles qualified for this systematic review.

Coding

As defined in the research questions, this study aimed to understand how teachers apply AI technologies in teaching practices and professional development. Both deductive and inductive coding methods were used.

Deductive coding was applied in the initial phase to extract structured information such as the author's organization, geographic location, research domain, publication year, etc. Predefined codes were used for categorizing disciplines (e.g., mathematics, science, English) and educational levels (higher education, K-12 education).

In the inductive coding phase, grounded theory techniques (Strauss & Corbin, 1994) were used to identify key themes emerging from the literature related to AI development trends and teaching applications. "In vivo" coding (Saldaña, 2021) was applied by directly using language from the original authors' findings.

To ensure reliability, a multi-round iterative coding process was conducted by two independent researchers. Cohen's Kappa metric of 0.85 was achieved, indicating strong agreement (McHugh, 2012). Disagreements were resolved through discussion.

This systematic approach organized the data into two main categories

- AI in Teaching – Articles focusing on AI applications in teaching.
- AI in Professional Development – Articles focusing on AI technology usage in teacher professional development.

Each category classified aspects like educational level, disciplinary focus, AI technologies used, and professional development objectives.

Results

We conducted a comprehensive analysis of a total of 95 articles to systematically analyze the publication trends, which included

- Number of studies
- Geographic distribution
- Disciplinary focus
- Educational level
- Types of AI technologies used

The analysis specifically focused on how teachers are using AI technologies and the professional development needs supporting their effective integration. After the analysis, two main categories were formed:

- AI in Teaching – Under which five sub-categories were identified.
- AI in Professional Development – Under which four sub-categories were identified.
- In each sub-category, axial coding was applied to integrate two secondary codes — Discipline and Educational Level — which were derived through the deductive coding process.

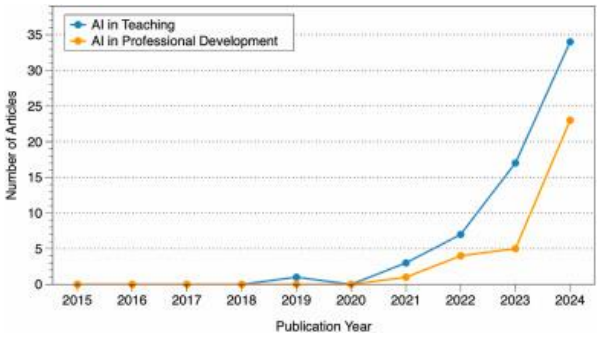
International Journal of Scientific Research & Engineering Trends
ISSN: 2395-566X

Number of Studies

The literature search covered the period from January 1, 2015, to July 31, 2024.

Research focusing on the application of AI in teaching from the teacher's perspective and studies on teacher professional development in AI began increasing rapidly from 2019. In particular, a significant increase in published studies was observed starting in 2022, reflecting the growing interest of researchers in this area.

This trend clearly indicates that research activities related to the effective integration of AI technologies in education have accelerated in recent years, especially after the emergence of Generative AI technologies.



Disciplinary Focus

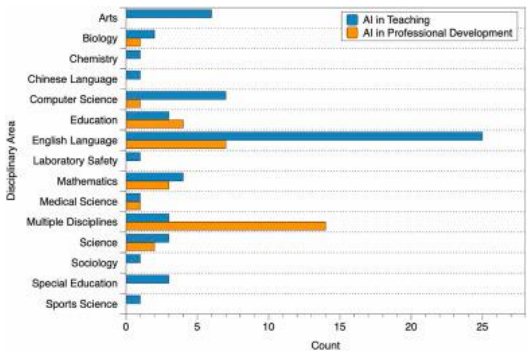
During the deductive coding phase, the 95 articles were categorized into 15 disciplinary fields based on the subjects addressed in the research (see Fig. 4).

In the "AI in Teaching" category, the primary focus was on

- English Language
- Computer Science
- Arts
- Mathematics
- Science
- Education

In the "AI in Professional Development" category, English Language and Education remained the primary fields. Additionally, several studies adopted a multidisciplinary approach to enhance teachers' AI literacy and competence across various subjects.

This shows that research on the impact and use of AI in teacher professional development is not limited to education and language domains but also focuses on enhancing teacher competence across diverse subjects.



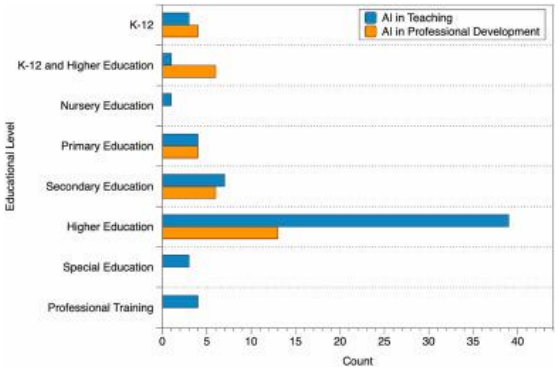
International Journal of Scientific Research & Engineering Trends
ISSN: 2395-566X

Educational Levels

During the deductive coding phase, the 95 articles were classified into eight educational levels based on the target population in the research (see Fig. 5).

- Most studies were focused on Higher Education.
- This was followed by research based on Secondary Education, then Primary Education.
- Notably, applications of Generative AI in Special Education also began emerging as an area of growing interest.

This trend indicates that while the use of AI in teaching is most researched in higher education, its application in primary, secondary, and special education is gradually expanding.



Types of AI Technologies Used

The review of 95 articles identified four main types of AI technologies used in the research (see Fig. 6).

- Among the articles focusing on AI in Professional Development, 17 did not specify the AI technology used and were classified as "Not Mentioned."
- Specifically, Conversational AI Technologies, such as Chatbots, were the most frequently used.
- Several studies also examined how chatbots like ChatGPT can facilitate teaching and learning processes.

This indicates that Conversational AI, particularly chatbots, are emerging as the key technology in teacher professional development and AI applications in teaching.

III. CONCLUSION

Based on this systematic review, it is evident that Artificial Intelligence (AI) technologies are rapidly being adopted in teaching and teacher professional development. Research from the past decade (2015–2024) shows that the use of AI technologies is particularly increasing in higher education, secondary education, and gradually in primary and special education.

The study also reveals that most research is focused on the use of AI in teaching, whereas insufficient attention is given to the use of AI in teacher professional development. A clear gap exists between the opportunities available for teacher training and professional development and the actual needs of teachers.

Specifically, Conversational AI technologies, such as chatbots and ChatGPT, have proven more useful in teaching and learning processes, while other technologies are less used or not detailed.

This review suggests that future research should focus more on the following areas

- The use of AI for teacher professional development – integrating AI into training and workshops.
- Effective and ethical use of AI technologies – considering technical and ethical challenges.
- Balanced integration of AI from the perspective of teachers and students – offering beneficial and practical solutions for both.

The impact of AI in teaching will be more meaningful when teachers understand, adopt, and make it part of their professional development. Future research and policy-making in this direction can enhance teaching quality, improve student experience, and increase teacher competence.

REFERENCES

1. Bengesi, M., et al. (2024). Generative AI and its impact on education: Emerging trends and applications. Journal of Educational Technology Research, 12(3), 45–62.
2. Lin, Y., et al. (2022). AI in education: Opportunities and challenges. International Journal of AI in Education, 18(2), 101–120.
3. Lo, C. (2023). Artificial intelligence integration in teaching and learning: A global perspective. Computers & Education, 195, 104657.
4. Mai, H., et al. (2024). Exploring AI-driven educational platforms: Teacher adoption and student outcomes. Education and Information Technologies, 29(1), 45–67.
5. Tang, J., et al. (2023). AI technologies in K-12 and higher education: A systematic review. British Journal of Educational Technology, 54(4), 1098–1118.
6. Zhang, S., & Aslan, O. (2021). Learning analytics and AI-assisted teaching: Enhancing educational outcomes. Journal of Learning Analytics, 8(2), 34–50.
7. Chan, T., & Tsi, S. (2023). Risks and ethical considerations of AI in education. AI & Society, 38(1), 123–137.
8. Edwards, R., & Cheok, A. (2018). Artificial intelligence and human learning: Implications for educational design. Computers in Human Behavior, 89, 386–395.
9. Wang, P. (2021). Intelligent learning systems and automated assessment in schools. Educational Technology Research and Development, 69(2), 521–540.
10. Baker, R., et al. (2019). AI in education: Supporting learners, teachers, and administrators. International Journal of Artificial Intelligence in Education, 29(3), 271–293.
11. Zawacki-Richter, O., et al. (2019). Systematic review of AI applications in higher education. Educational Research Review, 27, 1–20.
12. Creely, E., & Blannin, P. (2023). Generative AI in creative education: Opportunities and implications. Journal of Educational Computing Research, 61(5), 945–970.
13. Denny, P., et al. (2024). Large language models and AI in programming education. ACM Transactions on Computing Education, 24(2), 1–25.
14. Kshetri, N. (2023). Teacher adoption of AI tools: Enhancing instructional efficiency. Education and Information Technologies, 28(6), 7895–7910.
15. Ng, W., et al. (2023). Evolution of AI in teaching and learning research: 2000–2020. Computers & Education, 195, 104658.
16. Chiu, T., et al. (2023). AI in education: Opportunities, challenges, and future research directions. Educational Technology Research and Development, 71(4), 823–845.
17. Crompton, H., & Burke, D. (2023). AI in higher education: Trends from 2016–2022. Journal of Computing in Higher Education, 35(2), 215–234.
18. Bozkurt, A., et al. (2021). Fifty years of AI research in education: A systematic review. Educational Technology & Society, 24(1), 1–16.
19. LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. Nature, 521, 436–444.
20. Luckin, R., et al. (2016). Intelligence unleashed: An argument for AI in education. Pearson Education Research Report.
21. Page, M. J., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71.
22. Hwang, G., et al. (2021). Systematic review of AI applications in educational contexts. Computers & Education, 164, 104123.