IJTE International Journal of Technology in Education
www.ijte.net

Artificial Intelligence-Driven Innovation in Professional Education: A Scoping Review of Transformative Teaching and Learning Practices

James Russo A. Taga [1 *], Joseph L. Gelacio [2], Hananeel Jay A. Cabiling [3]

[1] Bukidnon State University, Malaybalay City, Bukidnon, Philippines, 0000-0003-4372-7982
[2] Bukidnon State University, Malaybalay City, Bukidnon, Philippines, 0009-0005-2778-0769
[3] Bukidnon State University, Malaybalay City, Bukidnon, Philippines, 0009-0006-2208-8383
* Corresponding author: James Russo A. Taga (jamesrussotaga@buksu.edu.ph)

Article Info

Article History

Received:
24 November 2025

Revised:
15 March 2026

Accepted:
28 April 2026

Published:
18 June 2026

Keywords

Artificial Intelligence
Professional education
Transformative teaching
Learning practices

Abstract

This scoping review examines the transformative role of artificial intelligence (AI) in Professional Education by mapping contemporary applications that enhance teaching effectiveness and learning outcomes. Guided by the Arksey and O'Malley (2005) framework and PRISMA-ScR guidelines, the study systematically analyzed 58 peer-reviewed articles published between 2019 and 2025 across four major databases: Google Scholar, ERIC, Scopus, and Web of Science. Findings reveal five overarching themes that capture the breadth of AI integration in tertiary professional programs: AI-enabled personalization, intelligent assessment and analytics, AI-mediated instructional design, simulation-based experiential learning, and ethical and institutional challenges. Across these domains, AI demonstrates significant potential to strengthen learner engagement, support differentiated instruction, and optimize decision-making through data-driven insights. However, concerns surrounding algorithmic bias, data privacy, infrastructure limitations, and faculty readiness underscore the need for responsible implementation. This review provides a comprehensive synthesis to guide educators, policymakers, and institutions in leveraging AI ethically and effectively to advance 21st-century Professional Education.

Citation: Taga, J. R. A., Gelacio, J. L., & Cabiling, H. J. A. (2026). Artificial intelligence-driven innovation in professional education: A scoping review of transformative teaching and learning practices. *International Journal of Technology in Education (IJTE), 9*(3), 729-744. https://doi.org/10.46328/ijte.6201

ISSN: 2689-2758 / © International Journal of Technology in Education (IJTE).

Introduction

The rapid expansion of artificial intelligence (AI) has reshaped how higher education institutions conceptualize and deliver instruction, particularly within Professional Education where competency-based, practice-oriented learning is essential. With the rise of intelligent tutoring systems, adaptive learning platforms, analytics-driven assessments, and AI-mediated content creation, tertiary programs are increasingly utilizing technology to enhance instructional quality and learner outcomes (Sailer et al., 2024). Global developments between 2019 and 2025 have accelerated this momentum, as AI tools evolved to support personalization, provide real-time feedback, automate instructional design, and simulate complex real-world scenarios (Kochmar et al., 2021). This intersection between AI innovation and Professional Education reflects broader 21st-century shifts toward digital transformation, future-ready skills, and evidence-based pedagogical practices. As the demands on future professionals grow more complex, higher education programs must explore how AI can strengthen teaching effectiveness, learning engagement, and overall readiness for diverse professional environments (Zhang & Zhang, 2024).

Recent studies suggest that AI technologies can support transformative pedagogical practices by offering differentiated learning pathways, improving assessment efficiency, and expanding access to immersive experiential learning. AI-powered simulations, virtual labs, machine learning–based analytics, and generative tools have become integral in disciplines such as teacher education, health sciences, engineering, business, and applied social sciences (Mullah & Jayachandran, 2025). These tools enable learners to rehearse skills, receive instant data-informed feedback, and engage with dynamic content that mirrors real-world professional challenges. At the same time, emerging literature highlights critical challenges—including ethical concerns, data privacy issues, inequitable access, algorithmic bias, and gaps in faculty readiness—that shape the instructional value and sustainability of AI integration (Alzahrani, 2024). Collectively, existing research indicates both the transformative potential and the complexities of leveraging AI in Professional Education, underscoring the urgency for systematic and comprehensive examination.

Although interest in AI for teaching and learning has grown substantially, the research landscape remains fragmented, conceptually diverse, and rapidly evolving. Existing studies vary widely in their focus—some examine adaptive learning, others explore automated assessments, while many document the growing role of generative AI in instructional design—but few provide a holistic synthesis tailored to the unique demands of Professional Education (Choi, 2025). Much of the literature focuses on general higher education contexts without recognizing the specialized, skills-based nature of professional programs that require high levels of practical application, ethical judgment, and domain-specific competence (Tastanbekova et al., 2021). Moreover, no consolidated review currently maps how AI innovations collectively shape transformative teaching and learning across professional fields, nor how emerging opportunities and challenges interact within this context (Chen et al., 2020). These gaps highlight the need for a comprehensive, methodologically rigorous scoping review that can capture the breadth of AI applications, identify dominant patterns, and illuminate pedagogical implications for 21st-century Professional Education.

To address this gap, the present study conducts a scoping review following the Arksey and O'Malley (2005)

framework and guided by PRISMA-ScR protocols to systematically map AI-driven innovations influencing teaching and learning in Professional Education from 2019 to 2025. Using four major academic databases—Google Scholar, ERIC, Scopus, and Web of Science—the review synthesizes empirical and conceptual studies examining AI-enhanced personalization, intelligent assessment, content generation, simulations, and institutional or ethical considerations. Through thematic analysis and structured data charting, the study identifies five overarching themes that collectively describe how AI technologies are transforming pedagogical practices in professional programs. This review not only organizes existing scholarship but also clarifies emerging trends, pedagogical opportunities, and systemic challenges that shape AI integration in tertiary education. Ultimately, this research provides a comprehensive knowledge base to guide educators, policymakers, curriculum designers, and institutions in making informed, ethical, and future-ready decisions about AI adoption in Professional Education.

Objectives

This study explored, through a scoping review, the existing body of literature on AI-driven innovation in Professional Education to generate a comprehensive understanding of its instructional applications, transformative teaching practices, and implications for 21st-century learning. The review further aimed to elucidate the emerging opportunities and challenges associated with artificial intelligence as it reshapes pedagogical design, learner engagement, assessment, and professional preparation in higher education institutions.

Specifically, this study aspired to answer the following objectives:

1. Examine the scope, trends, and methodological characteristics of existing literature on AI-driven teaching and learning innovations in Professional Education;
2. Analyze the pedagogical opportunities, challenges, and ethical considerations associated with AI integration in Professional Education contexts;
3. Identify research gaps and propose future directions for the effective, inclusive, and responsible adoption of artificial intelligence in Professional Education; and
4. Develop a conceptual model illustrating key dimensions, relationships, and best practices for leveraging AI to enhance transformative teaching and learning in Professional Education.

Method

This study employed a scoping review methodology to systematically map existing studies on AI-driven innovation and transformative teaching and learning practices in Professional Education. Guided by the foundational framework of Arksey and O'Malley (2005) and enhanced by the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews), the review aimed to provide a structured understanding of how artificial intelligence is being leveraged to support, enhance, or reform instructional practices in tertiary professional programs. Given the rapid evolution of AI technologies and their increasing relevance in educational contexts, a scoping review provided an appropriate methodological approach to capture the breadth, diversity, and emerging nature of the research landscape.

Unlike traditional systematic reviews that focus on narrowly defined questions, scoping reviews follow an

iterative, flexible, and exploratory pathway. This approach is particularly suitable for AI in education, where conceptual frameworks, applications, and empirical evidence are continuously evolving across disciplines. Following Arksey and O'Malley's five-stage protocol—identifying research questions, searching for relevant studies, selecting studies, charting data, and synthesizing findings—this study ensured methodological transparency, analytic rigor, and conceptual cohesiveness. The PRISMA-ScR flow diagram was also used to document the identification, screening, eligibility, and inclusion of studies throughout the review process (see Figure 1).

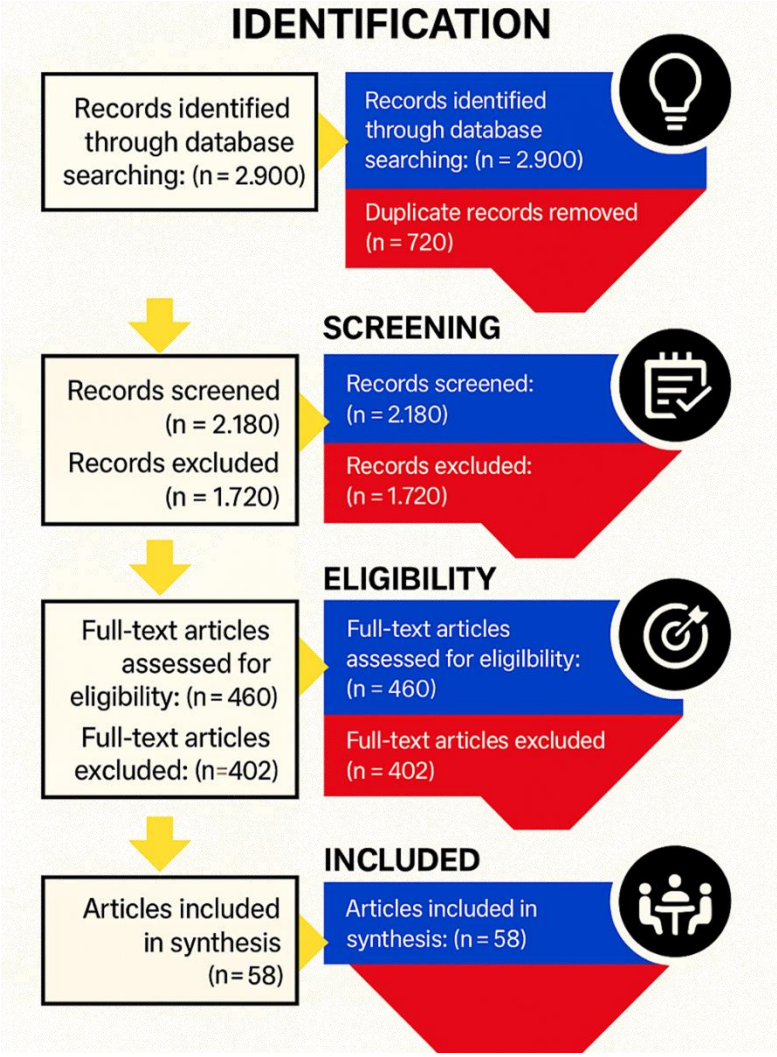

Figure 1. PRISMA- ScR Flow Chart of Searching, Selecting, and Abstracting Articles for the Scoping Review

Formulating the Research Questions

The first stage of the review involved developing broad yet focused research questions aligned with the exploratory purpose of scoping methodology. The study centered on the following guiding inquiries:

(1) What AI applications are currently utilized in Professional Education?

(2) How do AI-driven innovations influence teaching practices, learning outcomes, and instructional design? and

(3) What opportunities, challenges, and implications emerge from AI integration in Professional Education?

These questions were intentionally framed to allow the review to capture a wide spectrum of AI technologies, pedagogical models, and transformative practices that characterize contemporary professional training contexts.

Identifying and Retrieving Relevant Literature

A comprehensive search was conducted across Google Scholar, ERIC, Scopus, and Web of Science, selected for their extensive coverage of scholarly work in education, technology, and pedagogy. The search focused on studies published from 2019 to 2025, a period representing major advancements in artificial intelligence and its educational applications. A keyword-driven strategy was adopted, utilizing combinations such as "Artificial Intelligence in Professional Education," "AI-driven teaching and learning," "Educational AI applications," "AI for teacher education," "AI-enhanced learning in tertiary programs," and "Machine learning in higher education." Boolean operators (AND/OR) were used to refine and expand search combinations. Only peer-reviewed journal articles, book chapters, and high-quality conference proceedings were included, and multiple search iterations were performed to ensure a robust and comprehensive dataset aligned with the objectives of the study.

Selection of Studies Based on Inclusion Criteria

The screening process followed the PRISMA-ScR flow, starting with the removal of duplicates, followed by abstract screening, and culminating in full-text review. Studies were included if they (a) explicitly examined AI applications in Professional Education or tertiary-level instruction, (b) explored teaching, learning, assessment, content creation, or instructional design using AI, (c) presented empirical evidence, theoretical discussions, or documented innovative educational applications, and (d) were published in English. Conversely, studies were excluded if they (a) focused solely on technical AI development without educational relevance, (b) discussed educational levels outside tertiary Professional Education, (c) lacked academic rigor or were purely opinion pieces, or (d) provided insufficient insights into teaching or learning practices. This multi-level filtering process ensured conceptual alignment, methodological soundness, and analytical relevance in the final pool of studies.

Data Charting and Organization

All included studies underwent a structured data charting process using an analytical matrix adapted from Arksey and O'Malley. Extracted information included author details, publication year, country of research, methodological design, type of AI technology used, educational context, pedagogical application, outcomes, and identified opportunities or challenges. Charting the data in this manner enabled systematic comparison across diverse studies and supported the identification of recurring patterns. This process facilitated the emergence of conceptual intersections such as AI-enabled personalization, intelligent assessment and analytics, AI-mediated content generation, simulation-based experiential learning, and institutional or ethical issues. Through systematic organization, the matrix improved analytical rigor, coherence, and depth in synthesizing the research landscape.

Data Synthesis, Analysis, and Interpretation

The final phase involved synthesizing charted data through qualitative content analysis aimed at identifying shared concepts, divergent insights, and cross-cutting patterns. A multi-step coding process was used to categorize findings and cluster similar ideas into broader conceptual categories. Through iterative refinement, five major themes emerged that characterize AI-driven innovation in Professional Education: AI-enabled personalization and adaptive learning, intelligent assessment and analytics, AI-mediated instructional design, AI-supported simulations and experiential learning, and ethical, pedagogical, and institutional challenges. These themes reflect both the transformative potential of artificial intelligence and the pressing considerations required for its responsible integration. Findings were further documented in the PRISMA-ScR flow diagram, ensuring transparency in the screening and selection process and supporting the credibility of the review's methodological procedures.

Results and Discussion

Theme 1: AI-Enabled Personalization and Adaptive Learning Pathways

Artificial intelligence has enabled sophisticated personalization mechanisms in professional education, allowing instruction to adjust dynamically to learners' pace, prior knowledge, and performance (Xu, 2025). Adaptive learning systems, such as intelligent tutoring platforms and AI-powered courseware, analyze students' real-time data to identify learning gaps and propose targeted interventions (Gutierrez et al., 2025). These tools support differentiated instruction by offering individualized tasks, scaffolded hints, and immediate practice opportunities based on competency levels. Professional education programs—especially those requiring mastery of complex skills such as pedagogy, law, health sciences, and engineering—benefit from these tailored pathways because they reduce cognitive overload (Dorri et al., 2025). As a result, learners engage in more efficient, meaningful, and competency-aligned learning experiences.

Beyond content adaptation, AI personalization also enhances learner agency by enabling self-directed learning. Professionally oriented students can set goals and track their progress through dashboards that interpret their data patterns and provide actionable feedback (Ivashchenko & Lareva, 2020). This encourages metacognitive development as learners become more aware of what they know and what they still need to strengthen. The integration of personalization also helps instructors differentiate instruction more effectively without increasing workload, as AI automates the most time-consuming aspects of monitoring (Bianchi & Rossi, 2025). Ultimately, personalized learning pathways build a culture of continuous improvement, allowing institutions to implement flexible and learner-centered professional education programs (Akintola et al., 2025).

Theme 2: Intelligent Assessment, Feedback, and Analytics for Learning Improvement

AI-supported assessment tools are transforming how professional education evaluates learner performance, particularly through automated scoring, pattern recognition, and predictive analytics (Owan et al., 2023). These tools streamline grading of essays, case analyses, problem-solving tasks, and simulations—activities traditionally

requiring significant instructor time. Automated feedback engines provide point-by-point insights that help learners understand errors immediately and revise their work iteratively (Lee & Moore, 2024). This shift expands formative assessment opportunities, allowing students to practice more frequently and reflect on their progress. In professional fields where mastery is critical, such as education, nursing, or technical training, AI-enhanced assessment strengthens the reliability and timeliness of evaluation (Xuto et al., 2025).

Learning analytics further support instructional decision-making by identifying trends in learner strengths, weaknesses, and engagement (Ifenthaler & Yau, 2020). AI systems can detect patterns indicating dropout risks, misconceptions, or declining performance, giving educators early warning to apply targeted interventions (Jain et al., 2025). They also support outcome-based education by mapping learner performance to course competencies and professional standards. Data visualizations generated by AI help instructors monitor class-wide trends and modify teaching strategies strategically (Liao et al, 2024). Collectively, these tools create a feedback-rich ecosystem where assessment is not merely evaluative but developmental, reinforcing a culture of continuous improvement in professional education.

Theme 3: AI-Mediated Instructional Design and Content Generation

Artificial intelligence tools are increasingly used to support instructional design by automating content creation, generating multimedia resources, and offering evidence-based recommendations for course development (Ruiz-Rojas et al., 2023). AI can quickly produce lesson drafts, simulations, problem sets, and scenario-based activities aligned with specific learning outcomes (Van Den Berg & Du Plessis, 2023). For professional education disciplines that require frequent updating—such as technology, business, or teacher training—AI provides a significant advantage by enabling rapid content revisions (Yan & Tang, 2025). Instructional designers and faculty can focus more on conceptual refinement and pedagogical strategy rather than manual content production (Amiri et al., 2025). This speeds up curriculum development cycles while maintaining high standards of quality and relevance.

In addition, AI facilitates multimodal learning by generating videos, quizzes, case studies, and visual explanations that appeal to diverse learner preferences (Fei et al., 2021). This capability supports universal design for learning (UDL), making instructional materials more accessible and inclusive. AI-driven design recommendations also help educators align activities with cognitive complexity, skill progression, and assessment types (Chang et al., 2023). These AI-mediated processes strengthen the coherence of curriculum, especially in competency-based professional programs (Mishra & Babiyola, 2025) As a result, institutions can scale high-quality course offerings while ensuring that content remains aligned with emerging industry trends and 21st-century skill requirements.

Theme 4: AI-Supported Simulations, Virtual Labs, and Experiential Learning

AI-powered simulations and virtual environments are redefining experiential learning in professional education by providing safe, interactive, and authentic practice spaces (Liaw et al., 2025). These tools replicate real-world scenarios such as teaching demonstrations, clinical procedures, business negotiations, laboratory experiments, or

legal casework. Simulated environments allow learners to rehearse complex tasks without the risks, costs, or logistical constraints of physical environments (Chernikova et al., 2020). AI systems track learner decisions, provide real-time feedback, and adjust scenario difficulty based on performance (Dai et al., 2024). Such experiences deepen conceptual understanding while improving procedural fluency.

Experiential learning enhanced by AI also supports the development of soft skills essential in professional practice, such as communication, teamwork, and problem-solving (Jung & Suh, 2024; Pawnsawan, 2025). Intelligent agents and virtual avatars simulate human interactions, enabling learners to practice interpersonal responses in realistic contexts (Zhang et al., 2025; Salvetti et al., 2025). This is particularly valuable in fields like education, where classroom management and student engagement can be simulated before actual teaching practice. AI-based virtual labs democratize access by allowing remote learners to gain hands-on experience previously limited by geographic, institutional, or resource constraints (Nelke et al., 2024; Hussein et al., 2024; Ojika et al., 2023). Overall, AI-enabled experiential learning enriches professional preparation by fostering competence, confidence, and readiness for real-world challenges (Alghowinem et al., 2024; Omar et al., 2023).

Theme 5: Ethical, Pedagogical, and Institutional Challenges in AI Integration

Despite its transformative potential, AI integration in professional education raises significant ethical and pedagogical challenges that institutions must address (Celik, 2022; Mouta et al., 2024). Concerns about data privacy, algorithmic bias, academic integrity, and surveillance require robust governance frameworks (Pandey & Kumar, 2025; Wach et al., 2023; Cubio, 2025). Educators and students often express uncertainty about how AI collects and uses learning data, creating trust issues that can hinder adoption. Additionally, inequalities in access to AI tools widen the digital divide between institutions and learners with varying technological capacities (Bulathwela et al., 2024; Durón & Jiménez-Preciado, 2025) . These challenges underscore the need for ethical guidelines, transparent data policies, and capacity-building initiatives to ensure responsible AI utilization (Azman & Tümkaya, 2025; Dhiman et al., 2025; Nguyen et al., 2022; Yan et al., 2025).

From a pedagogical perspective, overreliance on AI may risk diminishing human judgment, creativity, and relational aspects of teaching (Lim et al., 2023; Zhou & Peng, 2025; Moylan et al., 2025). Professional education, which often values mentorship, reflection, and interpersonal engagement, must balance automation with human-centered practice (Zhang, 2025; Alfredo, 2023). Faculty readiness also becomes a central concern; many educators feel unprepared or resistant to using AI tools due to skill gaps or fear of technology displacing traditional roles (Wang et al., 2023; Granström & Oppi, 2025). Institutions must therefore invest in sustained professional development, infrastructure support, and participatory decision-making processes (Tammets &Ley, 2023; Nazaretsky et al., 2022). By addressing these challenges holistically, professional education programs can harness AI ethically and sustainably while preserving learner-centered pedagogical values.

Emergent Model

The conceptual model presents five interrelated dimensions that outline the essential roles, relationships, and best

practices for leveraging artificial intelligence to enhance transformative teaching and learning in Professional Education (see Figure 2).

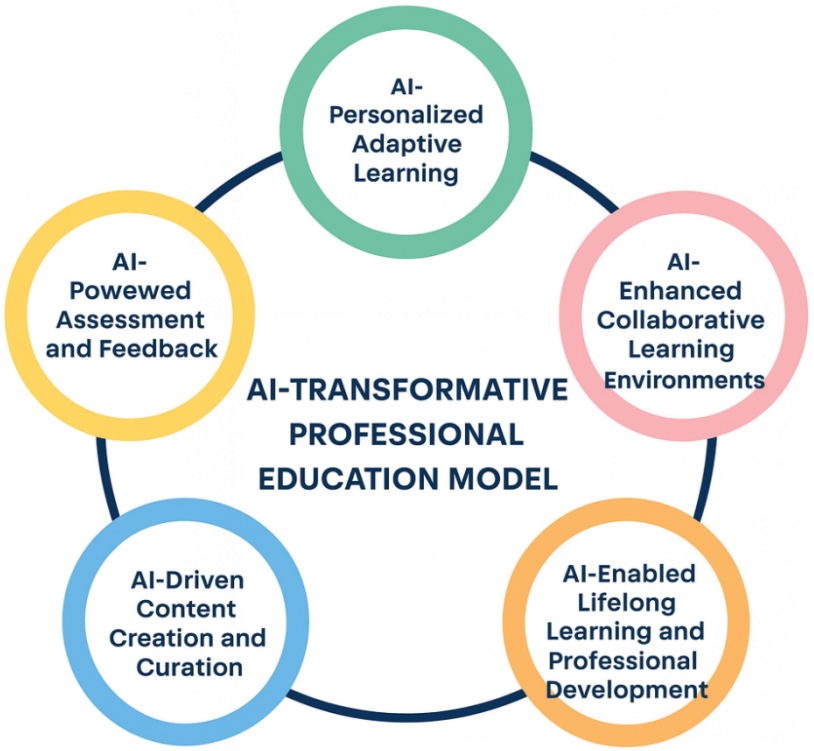

Figure 2. Five-Dimensional AI-Transformative Professional Education Model (AITPEM)

The first dimension, AI-Personalized Adaptive Learning, serves as the foundation of learner-centered transformation. By analyzing learners' prior knowledge, performance patterns, needs, and preferences, AI systems generate individualized pathways that support differentiated instruction. This highlights the best practice of using data-informed personalization to create responsive and competency-aligned learning experiences.

The second dimension, AI-Powered Assessment and Feedback, acts as the relational hub that links personalization with all other model components. Through automated scoring, predictive analytics, and real-time feedback, AI strengthens both formative and summative assessment. Its reciprocal relationship with personalization—where assessment data enhances adaptation and adaptive learning produces richer data for evaluation—reflects the best practice of maintaining continuous, analytics-driven assessment cycles crucial in Professional Education.

The third dimension, AI-Driven Content Creation and Curation, captures AI's role in transforming instructional design. Generative tools create multimodal materials, curate relevant resources, and recommend pedagogically sound sequences aligned with professional standards. Informed by data from personalization and assessment, this dimension underscores the best practice of using AI strategically to reduce teachers' design workload while improving the inclusivity, efficiency, and relevance of learning materials.

The fourth dimension, AI-Enhanced Collaborative Learning Environments, highlights AI's capacity to support

interactive, teamwork-oriented, and socially constructed learning. Through AI-facilitated discussions, virtual agents, peer-feedback systems, and collaborative simulations, learners engage in authentic knowledge-building aligned with workplace demands. This demonstrates the best practice of using AI to strengthen communication, interaction, and collaborative inquiry—core competencies in professional preparation.

Anchoring the model is the fifth dimension, AI-Enabled Lifelong Learning and Professional Development, which ensures the sustainability and ethical implementation of AI. This dimension includes teacher capacity building, institutional policies, technological infrastructure, and ethical safeguards. It reinforces the best practice that meaningful AI integration must be grounded in responsible governance and continuous professional upskilling. Its moderating influence across all other dimensions emphasizes that effective transformation requires institutional readiness, ethical alignment, and long-term support.

Together, these five dimensions illustrate how artificial intelligence functions as a connected ecosystem that reshapes pedagogy, assessment, collaboration, and lifelong learning. Their relationships form a unified framework of best practices that guide Professional Education institutions toward ethical, future-ready, and transformative teaching and learning environments.

Conclusion

Artificial intelligence is redefining the landscape of professional education by enhancing personalization, enabling sophisticated assessment systems, and strengthening pedagogical decision-making. The evidence mapped in this scoping review demonstrates that AI-driven innovation improves learner engagement, supports competency development, and expands access to flexible and adaptive learning pathways. Through personalized learning environments, intelligent analytics, and virtual simulations, AI provides both learners and educators with tools that make instruction more responsive, efficient, and aligned with real-world professional demands. These transformations underscore AI's potential to elevate the quality of teaching and learning, particularly in fields requiring complex, skills-based training.

However, the review also reveals emerging challenges that require deliberate policy and pedagogical attention. Ethical concerns—ranging from data privacy to algorithmic fairness—highlight the need for transparent governance protocols and informed implementation strategies. Educator preparedness and institutional readiness remain uneven, indicating gaps that could hinder inclusive AI adoption. While the pedagogical benefits of AI are evident, sustaining these gains depends on developing a culture of responsible integration where human expertise and technological innovation complement each other. Thus, AI's promise in professional education is substantial, but its long-term impact hinges on ethical, structural, and capacity-building considerations.

Recommendations

Based on the key insights from this scoping review, institutions must invest in sustained professional development programs focused on AI literacy, ethical data use, and pedagogically sound integration of AI tools. Educators

should be equipped to critically evaluate AI applications, customize them to specific course outcomes, and maintain meaningful human oversight in assessment and instructional decision-making. Policies promoting responsible AI deployment should include clear data protection protocols, transparency requirements, and mechanisms for monitoring algorithmic accuracy and fairness. Strengthening digital infrastructure, especially in resource-constrained contexts, will further ensure equitable access and broader adoption of AI-driven teaching innovations.

Future research should examine the long-term effects of AI-enhanced practices on learner outcomes, professional competencies, and employability across diverse fields of professional education. Comparative studies across disciplines, institutions, and geographic regions can provide deeper insight into contextual factors affecting AI effectiveness. Moreover, expanding research on student and educator perceptions will help identify barriers and opportunities for more human-centered integration of AI technologies. Overall, continuous evaluation, interdisciplinary collaboration, and evidence-based policymaking are essential to ensure that AI truly enhances the educational experience and supports the evolving demands of 21st-century professional practice.

Statements and Declarations

Acknowledgments/Notes: Not applicable.

During the preparation of this article, the authors did not use ChatGPT.

Supplementary Materials: Not applicable.

Author Contributions: All authors contributed equally. All authors have read and agreed to the published version of the manuscript.

Funding: The authors received no funding for the research.

Data Availability: Not applicable.

Ethics Approval: The study was performed in accordance with the study protocol and ethical guidelines and regulations.

Informed Consent: Not applicable.

Conflicts of Interest: The authors declare no conflicts of interest.

References

Akintola, A., Akintayo, M., Kadri, T., Oforgu, C., Michael, M., & Nwanna, M. (2025). Adaptive AI systems in

education: Real-time personalised learning pathways for skill development. *Journal of Artificial Intelligence, Machine Learning and Data Science*. https://doi.org/10.51219/jaimld/akinyemi-sadeeq-akintola/534

Alfredo, R., Echeverría, V., Jin, Y., Yan, L., Swiecki, Z., Gašević, D., & Maldonado, R. (2023). Human-centred learning analytics and AI in education: A systematic literature review. *Computers and Education: Artificial Intelligence, 6*, 100215. https://doi.org/10.1016/j.caeai.2024.100215

Alghowinem, S., Bagiati, A., Salazar-Gómez, A., & Breazeal, C. (2024). Leading in the AI era: An interactive experiential hands-on learning approach for professionals and leaders. In *2024 ASEE Annual Conference & Exposition Proceedings*. https://doi.org/10.18260/1-2--47719

Alzahrani, A. (2024). Unveiling the shadows: Beyond the hype of AI in education. *Heliyon, 10*, e30696. https://doi.org/10.1016/j.heliyon.2024.e30696

Amiri, S., Islam, M., Akter, N., Kabir, S., & Mamun, M. (2025). Effective teaching strategies: A deep dive into pedagogy. *International Journal of Science and Research Archive*. https://doi.org/10.30574/ijsra.2025.15.1.1055

Azman, Ö., & Tümkaya, S. (2025). Navigating the ethical landscape of AI integration in education: Balancing innovation and responsibility. *F1000Research*. https://doi.org/10.12688/f1000research.160011.1

Bianchi, L., & Rossi, S. (2025). The role of artificial intelligence in everyday applications in education. *International Journal of Emerging Trends in Information Technology (IJEIT)*. https://doi.org/10.64056/4ppeqb91

Bulathwela, S., Pérez-Ortiz, M., Holloway, C., Cukurova, M., & Shawe-Taylor, J. (2024). Artificial intelligence alone will not democratise education: On educational inequality, techno-solutionism and inclusive tools. *Sustainability, 16*, 781. https://doi.org/10.3390/su16020781

Celik, I. (2022). Towards intelligent-TPACK: An empirical study on teachers' professional knowledge to ethically integrate artificial intelligence (AI)-based tools into education. *Computers in Human Behavior, 138*, 107468. https://doi.org/10.1016/j.chb.2022.107468

Chang, D., Lin, M., Hajian, S., & Wang, Q. (2023). Educational design principles of using AI chatbot that supports self-regulated learning in education: Goal setting, feedback, and personalization. *Sustainability, 15*, 12921. https://doi.org/10.3390/su151712921

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access, 8*, 75264–75278. https://doi.org/10.1109/ACCESS.2020.2988510

Chernikova, O., Heitzmann, N., Stadler, M., Holzberger, D., Seidel, T., & Fischer, F. (2020). Simulation-based learning in higher education: A meta-analysis. *Review of Educational Research, 90*, 499–541. https://doi.org/10.3102/0034654320933544

Choi, D. (2025). Exploring instructional design strategies for utilizing generative AI in early childhood teacher training programs. *The K Association of Education Research*. https://doi.org/10.48033/jss.10.1.25

Cubio, J. (2025). The influence of privacy, bias, and surveillance concerns on teachers' willingness to use artificial intelligence in education. *International Journal of Research and Innovation in Social Science*. https://doi.org/10.47772/ijriss.2025.903sedu0240

Dai, C., Ke, F., Pan, Y., Moon, J., & Liu, Z. (2024). Effects of artificial intelligence-powered virtual agents on learning outcomes in computer-based simulations: A meta-analysis. *Educational Psychology Review*.

https://doi.org/10.1007/s10648-024-09855-4

Dhiman, T., Chauhan, V., Kumar, A., Vasantha, M., & Kumar, A. (2025). Ethical crossroads: Navigating data privacy, bias, accountability and sustainability in AI-driven education. *Open Access Journal of Multidisciplinary Research*. https://doi.org/10.47760/oajmr.2025.v01i03.007

Dorri, R., Al-Omari, E., Al-Hassan, M., Mohamed, S., & Ansar, S. (2025). Global integration of adaptive quizzing in nursing education: Enhancing student performance and bridging educational gaps: A narrative review. *Nurse Education in Practice, 84*, 104334. https://doi.org/10.1016/j.nepr.2025.104334

Durón, N., & Jiménez-Preciado, A. (2025). Exploring the role of AI in higher education: A natural language processing analysis of emerging trends and discourses. *The TQM Journal*. https://doi.org/10.1108/tqm-10-2024-0376

Fei, N., Lu, Z., Gao, Y., Yang, G., Huo, Y., Wen, J., Lu, H., Song, R., Gao, X., Xiang, T., Sun, H., & Wen, J. (2021). Towards artificial general intelligence via a multimodal foundation model. *Nature Communications, 13*, 3094. https://doi.org/10.1038/s41467-022-30761-2

Granström, M., & Oppi, P. (2025). Assessing teachers' readiness and perceived usefulness of AI in education: An Estonian perspective. *Frontiers in Education*. https://doi.org/10.3389/feduc.2025.1622240

Gutierrez, R., Villegas-Ch, W., Navarro, A., & Luján-Mora, S. (2025). Optimizing problem-solving in technical education: An adaptive learning system based on artificial intelligence. *IEEE Access, 13*, 61350–61367. https://doi.org/10.1109/ACCESS.2025.3557281

Hussein, R., Zhang, Z., Amarante, P., Hancock, N., Orduña, P., & Rodríguez-Gil, L. (2024). Integrating personalized AI-assisted instruction into remote laboratories: Enhancing engineering education with OpenAI's GPT models. In *2024 IEEE Frontiers in Education Conference (FIE)* (pp. 1–7). https://doi.org/10.1109/FIE61694.2024.10892918

Ifenthaler, D., & Yau, J. (2020). Utilising learning analytics to support study success in higher education: A systematic review. *Educational Technology Research and Development, 68*, 1961–1990. https://doi.org/10.1007/s11423-020-09788-z

Ivashchenko, G., & Lareva, A. (2020). Goal setting using the SMART method in the disciplines of the professional cycle of the direction "Information systems and technologies" as a mechanism of self-realization. *Informatics in Education*, 35(7), 40–46. https://doi.org/10.32517/0234-0453-2020-35-7-40-46

Jain, A., Dubey, A., Khan, S., Panwar, A., Alkhatib, M., & Alshahrani, A. (2025). A PSO weighted ensemble framework with SMOTE balancing for student dropout prediction in smart education systems. *Scientific Reports, 15*. https://doi.org/10.1038/s41598-025-97506-1

Jung, D., & Suh, S. (2024). Enhancing soft skills through generative AI in sustainable fashion textile design education. *Sustainability, 16*, 6973. https://doi.org/10.3390/su16166973

Kochmar, E., Vu, D., Belfer, R., Gupta, V., Serban, I., & Pineau, J. (2021). Automated data-driven generation of personalized pedagogical interventions in intelligent tutoring systems. *International Journal of Artificial Intelligence in Education, 32*, 323–349. https://doi.org/10.1007/s40593-021-00267-x

Lee, S., & Moore, R. (2024). Harnessing generative AI (GenAI) for automated feedback in higher education: A systematic review. *Online Learning, 28*(3). https://doi.org/10.24059/olj.v28i3.4593

Liaw, S., Tan, J., Lim, S., Zhou, W., Yap, J., Ratan, R., Ooi, S., Wong, S., Seah, B., & Chua, W. (2023). Artificial intelligence in virtual reality simulation for interprofessional communication training: Mixed method

study. *Nurse Education Today, 122*, 105718. https://doi.org/10.1016/j.nedt.2023.105718

Liao, X., Zhang, X., Wang, Z., & Luo, H. (2024). Design and implementation of an AI-enabled visual report tool as formative assessment to promote learning achievement and self-regulated learning: An experimental study. *British Journal of Educational Technology, 55*, 1253–1276. https://doi.org/10.1111/bjet.13424

Lim, J., Leinonen, T., Lipponen, L., Lee, H., DeVita, J., & Murray, D. (2023). Artificial intelligence as relational artifacts in creative learning. *Digital Creativity, 34*, 192–210. https://doi.org/10.1080/14626268.2023.2236595

Mouta, A., Torrecilla-Sánchez, E., & Pinto-Llorente, A. (2024). Comprehensive professional learning for teacher agency in addressing ethical challenges of AIED: Insights from educational design research. *Education and Information Technologies, 30*, 3343–3387. https://doi.org/10.1007/s10639-024-12946-y

Moylan, R., Code, J., & O'Brien, H. (2025). Teaching and AI in the postdigital age: Learning from teachers' perspectives. *Teaching and Teacher Education*. https://doi.org/10.1016/j.tate.2024.104851

Mullah, A., & Jayachandran, S. (2025). AI-driven innovation in Education 4.0: An overview of generative AI tools, learning analytics, and gamified SQL learning. *International Journal of Environmental Sciences*. https://doi.org/10.64252/829vnm63

Nazaretsky, T., Ariely, M., Cukurova, M., & Alexandron, G. (2022). Teachers' trust in AI-powered educational technology and a professional development program to improve it. *British Journal of Educational Technology, 53*, 914–931. https://doi.org/10.1111/bjet.13232

Nelke, S., Kohen-Vacs, D., Khomyakov, M., Rosienkiewicz, M., Helman, J., Cholewa, M., Molasy, M., Górecka, A., González, J., Bourgain, M., Sagar, A., Berselli, G., Blank, D., Winokur, M., & Benis, A. (2024). Enhancing lessons on the Internet of Things in science, technology, engineering, and medical education with a remote lab. *Sensors, 24*, 96424. https://doi.org/10.3390/s24196424

Nguyen, A., Ngo, H., Hong, Y., Dang, B., & Nguyen, B. (2022). Ethical principles for artificial intelligence in education. *Education and Information Technologies, 28*, 4221–4241. https://doi.org/10.1007/s10639-022-11316-w

Ojika, F., Owobu, W., Abieba, O., Esan, O., Ubamadu, B., & Daraojimba, A. (2023). Transforming cloud computing education: Leveraging AI and data science for enhanced access and collaboration in academic environments. *Journal of Frontiers in Multidisciplinary Research*. https://doi.org/10.54660/.ijfmr.2023.4.1.138-156

Omar, Z., Harun, M., Ishar, N., Mustapha, N., & Ismail, Z. (2023). Enhancing professional development and training through AI for personalized learning: A framework to engaging learners. *International Journal on e-Learning and Higher Education*. https://doi.org/10.24191/ijelhe.v19n3.1937

Owan, V., Abang, K., Idika, D., Etta, E., & Bassey, B. (2023). Exploring the potential of artificial intelligence tools in educational measurement and assessment. *Eurasia Journal of Mathematics, Science and Technology Education, 19*(7). https://doi.org/10.29333/ejmste/13428

Pandey, H., & Kumar, N. (2025). Ethical challenges in AI use in schools: A study of data privacy, surveillance, and bias. *EPRA International Journal of Multidisciplinary Research (IJMR)*. https://doi.org/10.36713/epra20929

Pawnsawan, P. (2025). Gamified flipped design innovation classroom with AI chatbot to promote soft skills for student innovators. *International Journal of Information and Education Technology, 15*(7), 2345.

https://doi.org/10.18178/ijiet.2025.15.7.2345

Ruiz-Rojas, L., Acosta-Vargas, P., De-Moreta-Llovet, J., & González-Rodríguez, M. (2023). Empowering education with generative artificial intelligence tools: Approach with an instructional design matrix. *Sustainability, 15*, 11524. https://doi.org/10.3390/su151511524

S., S., Mishra, H., & Babiyola, A. (2025). Development knowledge graphs for intelligent curriculum design in education with artificial intelligence. *International Journal of BIM and Engineering Science*. https://doi.org/10.54216/ijbes.100101

Sailer, M., Maier, R., Berger, S., Kastorff, T., & Stegmann, K. (2024). Learning activities in technology-enhanced learning: A systematic review of meta-analyses and second-order meta-analysis in higher education. *Learning and Individual Differences, 110*, 102446. https://doi.org/10.1016/j.lindif.2024.102446

Salvetti, F., Bertagni, B., Contardo, I., Gardner, R., Rudolph, J., & Minehart, R. (2025). AI-driven avatars in medical training: Personalized feedback for enhanced learning. *International Journal of Advanced Corporate Learning, 18*, 46–59. https://doi.org/10.3991/ijac.v18i3.52595

Tammets, K., & Ley, T. (2023). Integrating AI tools in teacher professional learning: A conceptual model and illustrative case. *Frontiers in Artificial Intelligence, 6*, 1255089. https://doi.org/10.3389/frai.2023.1255089

Tastanbekova, N., Abenova, B., Yessekeshova, M., Sagalieva, Z., & Abildina, G. (2021). Development of professional skills in the context of higher school dual education. *International Journal of Emerging Technologies in Learning, 16*(10). https://doi.org/10.3991/ijet.v16i10.19373

Van Den Berg, G., & Du Plessis, E. (2023). ChatGPT and generative AI: Possibilities for its contribution to lesson planning, critical thinking and openness in teacher education. *Education Sciences, 13*(10), 998. https://doi.org/10.3390/educsci13100998

Wach, K., Duong, C., Ejdys, J., Kazlauskaitė, R., Korzyński, P., Mazurek, G., Paliszkiewicz, J., & Ziemba, E. (2023). The dark side of generative artificial intelligence: A critical analysis of controversies and risks of ChatGPT. *Entrepreneurial Business and Economics Review, 11*(2), 7–32. https://doi.org/10.15678/eber.2023.110201

Wang, X., Li, L., Tan, S., Yang, L., & Lei, J. (2023). Preparing for AI-enhanced education: Conceptualizing and empirically examining teachers' AI readiness. *Computers in Human Behavior, 146*, 107798. https://doi.org/10.1016/j.chb.2023.107798

Xu, X. (2025). AI optimization algorithms enhance higher education management and personalized teaching through empirical analysis. *Scientific Reports, 15*. https://doi.org/10.1038/s41598-025-94481-5

Xuto, P., Prasitwattanaseree, P., Chaiboonruang, T., Chaiwuth, S., Khwanngern, P., Nuntakwang, C., Nimarangkul, K., Suwansin, W., Khiaokham, L., & Bressington, D. (2025). Development and evaluation of an AI-assisted answer assessment (4A) for cognitive assessments in nursing education. *Nursing Reports, 15*, 30080. https://doi.org/10.3390/nursrep15030080

Yan, Y., Liu, H., & Chau, T. (2025). A systematic review of AI ethics in education. *Journal of Global Information Management*. https://doi.org/10.4018/jgim.386381

Yan, Z., & Tang, Q. (2025). Integrating AI-generated content tools in higher education: A comparative analysis of interdisciplinary learning outcomes. *Scientific Reports, 15*. https://doi.org/10.1038/s41598-025-10941-y

Zhang, J. (2025). Ethics of artificial intelligence in education: Balancing automation and human-centered learning. *Applied Mathematics and Nonlinear Sciences, 10*. https://doi.org/10.2478/amns-2025-0843

Zhang, J., & Zhang, Z. (2024). AI in teacher education: Unlocking new dimensions in teaching support, inclusive learning, and digital literacy. *Journal of Computer Assisted Learning, 40*, 1871–1885. https://doi.org/10.1111/jcal.12988

Zhang, K., Gong, W., Liu, Q., Lu, J., Bao, M., Liu, X., Zhu, L., & Chen, E. (2025). Intelligent interaction platform for personalized digital tutor: Advancing empathetic and adaptive learning experiences. In *Companion Proceedings of the ACM on Web Conference 2025*. https://doi.org/10.1145/3701716.3715182

Zhou, M., & Peng, S. (2025). The usage of AI in teaching and students' creativity: The mediating role of learning engagement and the moderating role of AI literacy. *Behavioral Sciences, 15*, 587. https://doi.org/10.3390/bs15050587