Integrating Artificial Intelligence in Teacher Education: A Systematic Analysis

Dr. Gopikanta Suna[1], Miss. Suchismita[2], Mr. Tripurari Das[3]

[1]Assistant professor, G.M. University, Sambalpur
[2]Pradhan, Research scholar, G.M. University, Sambalpur
[3]Lab Assistant, G.M. University, Sambalpur

ABSTRACT: The current work is a systematic review paper that examines the function and significance of artificial intelligence (AI) in teacher education. The researcher gathered almost fifty articles from various platforms, including Google Scholar, Science Direct, Research Gate, and others, on AI and teacher education. Additionally, those publications' analysis reveals a few key areas and their significance for teacher preparation. By delivering tailored learning experiences, improving instructional strategies, and providing data-driven insights etc. After collecting the article from the above sources, the investigator analyzed all the article on four major points e.g. AI and digital learning, AI and Teacher Education, AI and pedagogical leaning, AI and challenges in teaching learning process systematically, where the investigator found few points and analyzed vividly, at the end the view concern to the Artificial intelligence (AI) has the potential to completely transform Teacher Education. But in order to fully enjoy these advantages, the ethical, equitable, and preparedness issues around AI must be resolved.

KEY WORDS: Artificial Intelligence, Challenges, Digital learning, Teacher Education.

INTRODUCTION

Artificial intelligence (AI) is the invention of computer programs capable of doing tasks that would ordinarily need human intelligence. Some of these tasks include problem solving, judgment, understanding natural language, pattern recognition, and data-driven learning. AI systems attempt to emulate human cognitive functions, and they frequently improve over time as a result of new knowledge or experience (Agibova, 2020). Artificial intelligence (AI) is the ability of a computer or robot under computer control to execute tasks normally performed by intelligent organisms (Bikowsky, 2022). The phrase is often used to represent the endeavor of developing artificial intelligence systems with human-like cognitive processes such as reasoning, meaning-finding, generalization, and experience-based learning. Since their inception in the 1940s, digital computers have been designed to execute highly complex tasks with remarkable skill, such as discovering proofs for mathematical theorems or playing chess. Even with continual increases in computer memory and processing speed, no software can fully replicate human adaptability over a wider range of topics or in activities requiring a high level of common knowledge. However, some systems have outperformed human specialists and professionals in specialized activities. So, in this restricted sense, artificial intelligence can be found in a variety of applications, including medical diagnosis, computer search engines, speech or handwriting recognition, and chatbots (Aubusson and Schuck, 2013). In artificial intelligence, it is defined as a methodical search through a set of possible actions to reach a given goal or solution. There are two types of problem-solving techniques: special-purpose and general-purpose. A special-purpose approach is suited to a specific problem and frequently makes use of highly specialized characteristics of the problem's context (Agibova,2020). In contrast, a general-purpose technique is applicable to a wide range of scenarios. Means-end analysis is a general-purpose AI technique that reduces the gap between the present state and the final aim incrementally.

METHODOLOGY
METHODS AND MATERIALS

A comprehensive literature review was done from Google Scholar, Web of Science, Educational Resource Information Centre (ERIC) ProQuest Digital Platform, Shodhganga, Shodhgaungotri and Research Gate. Dissertations and articles were undertaken from 2014 to 2024. These electronic platforms were selected and obtained the review paper on AI and teacher education. The

reference list of the retrieved articles and evaluated papers had been evaluated for many studies. After collection of the article paper, the researcher doing intensive analysis on all the article and develop a thematic review on that.

SAMPLES

Almost more than 50 articles were studied by the researcher for explaining the various aspect of AI. The researcher also emphasized that role of AI in teacher education. Few studies were undertaken that only emphasize role of AI as a strategy for the teaching-learning process. which influence the learning achievement of student at different level of education. Therefore, a systematic review was collected by the researcher and evaluated thoroughly.

ANALYSIS AND DISCUSSION

After collection of the article from the online platform, the investigator read all the paper intensively and summarized on the four ground as per the review article and their focus point was concern, the investigator summarized all review in four important points e.g. AI and digital learning ,AI and teacher Education ,AI and pedagogical learning , AI and challenges .

RESULT

AI AND DIGITAL LEARNING

The focus of AI on digital competence was identified, which is articulated in the literature in three ways: general digital competence, digital pedagogical competence, and the emerging concepts of professional digital competence. How future teachers learn to engage in the professional task of teaching in a digitally-embedded education system should be the basis for future research. Although the Professional Digital Competence Model (Starkey, 2020) proposes various tools that have great potential for improving language learning, their integration into classroom teaching practice has been cautious and underexplored. Moreover, there are potential limitations, such as the need for careful implementation to avoid an over-reliance on technology, and the importance of addressing these limitations in teacher preparation. Check the revised approach to education. This includes complete preparation for artificial intelligence tools to effectively include in language education (VOGT. K & Flindt. N, 2023) generated language models such as ChatGpt can provide specific equipment and support mechanisms such as course plan, teachers, and students. He also indicated that Chat Gpt has set the field of play by opening access to all teachers to the course plan. However, to realize their full potential in education, it is essential to approach these models with caution and critically assess their limitations and potential biases, recognizing that they are tools to support teaching and learning and do not replace teachers (Den Berg. G du & Plessis. E, 2023). AI-powered virtual students, designed in the SBL environment, emulate natural interactions to enhance preservice teachers' active teaching practices, moving beyond merely presenting information and thus increasing disciplinary-focused teaching enactments. The research community can refer to the results of the development of SBL in teacher training (Ke.F & et al., 2014). Artificial intelligence in education (AIE) can significantly improve teaching and learning by acting as an intelligent tutor, decision-making tool, or assistant. They proposed a conceptual framework to guide the implementation of AIE and identified 10 key research topics to advance the field. It highlights the need for new prior knowledge to avoid an over-reliance on AI features and for teachers to effectively integrate AI tools. It also highlights the value of interdisciplinary learning that includes topics related to AI. Policy implications include the need for new assessment methods that take AI skills into account. Furthermore, the study highlights the evolving role of AI in education and identifies several areas for future research (K. F. Chiu, 2023) AI is seen as a wake-up call for higher education institutions and policymakers across the country. It has been emphasized that today's students, living in an era of globalization of knowledge, deserve teachers who implement the best that technology can bring to learning (Moursund, D. and Bielefeldt, 1999). AI highlights the importance of interdisciplinary collaboration between education and IT professionals (Jen Hwang et al., 2020). We present the perspective of AI from EdTech companies and the perspective of experts on AI in the context of developing countries. The enormous potential of AI that EdTech companies can exploit in their future applications. AI has practical implications for transforming education systems in developing countries (Jaiswal and Joe Arun, 2021).
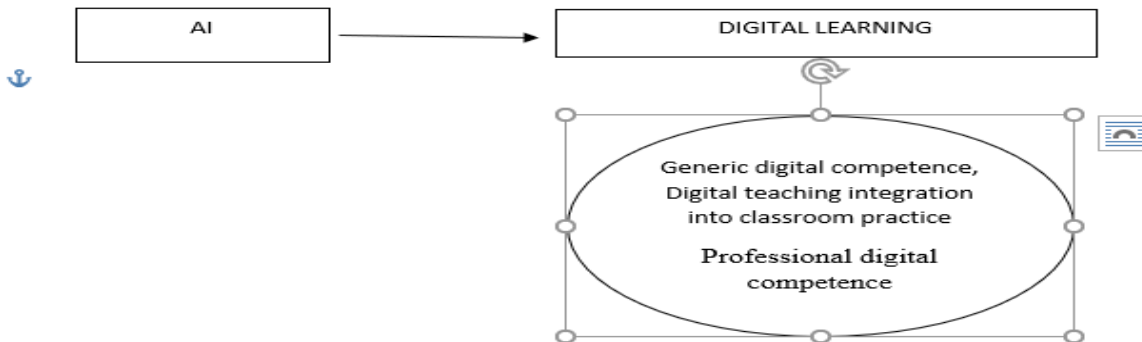
FIG. NO. 1 [AI AND DIGITAL LEARNING}

AI AND TEACHER EDUCATION

A potential strategy for using ChatGPT to improve lesson plans and classroom activities is to generate text that closely resembles human communication and demonstrate independent learning skills. Introducing ChatGPT into teacher training programs can help future teachers create engaging teaching materials. Teachers found this AI tool most useful in the following categories: lesson planning, creating assessment questions and homework, creating images, brainstorming and idea generation, creating educational games, text generation and text rewriting. Learn how AI tools such as Microsoft Copilot can be deployed to teachers and how teacher training programs can help improve educators' AI fluency. Additional research is needed to explore the long-term impact of this training on teaching practice and student outcomes (Siiman, L., 2024). The focus is on studying pre-service and in-service teachers' digital behaviors, perceptions, and skills regarding the use of AI and machine learning in teaching practice. (b) The main sources of data are behavioral, discourse, and statistical data. (c) Most studies use machine learning algorithms. (d) Few studies mention ethical approval. The implications are valuable for teachers and education authorities, informing decisions regarding the effective use of AI and LA technologies to support teacher education (Salas-Pilco et al., 2022) Regarding teachers' metacognitive skills, two exemplary projects were used to discuss the usefulness and relevance of AI methods of knowledge representation and knowledge elicitation as a methodology to support EBP. The researchers found that a key part of the future of AIEd lies in curating the role of AI as a methodology to support teacher training and continuing professional development, especially related to developing teachers' metacognitive skills related to teacher practice (Porayska-Pomsta, 2016) The course will integrate AI with other educational technology tools to create content, support research, and facilitate global publication, preparing students to be both consumers and producers of AI-driven educational content. In addition, the concepts and flows of the course, and the use of technologies used, creating a clear set of technologies skills for teachers, including reflection from the facilitator and student feedback (Panne et al. 2024). Technology is important to improve how they teach. Without these guidelines, teachers may not use technology effectively. This can affect how much of future teachers will learn more about using technology. Teachers became aware of AI education through their own teaching experiences. Furthermore, two learning paths were proposed to prepare technology and non-technology teachers to teach AI. These training paths give ideas for teachers and politicians to enhance teachers' abilities in promoting AI education and general education. (Vun yau et al. 2022). Educators have countered common techno-deterministic narratives and embraced AI as a means to support formative practices to assess and develop metacognition, self-regulation, responsibility, and well-being. Emerging ideas also include the need for AI education that critically integrates social and ethical perspectives and promotes a vision of a future with culturally, socially, and environmentally sustainable AI (Vartiainen et al., 2024). Educational Technology in Teacher Education through five areas of challenges and opportunities related to preparing PSTs to use technology meaningfully and equitably. The EnCITE framework provided a mechanism for teacher educators to integrate computing and digital technologies into their general teacher education and content-based courses. They hoped that teacher educators would use this framework to develop a coherent, integrated computing and technology curriculum for PSTs. (Vogel et al., 2024). Most teachers have a positive attitude toward AI in education; only 25% actually use AI tools in their teaching. ChatGPT, DALL-E, are the most

popular tools. Primary and secondary school teachers use AI to create content (e.g., presentations and videos), while higher education teachers mainly use it for academic and technical purposes, such as explaining how AI works, information retrieval, and search tasks. The survey results suggests that AI training for teachers needs to be adjusted according to specific needs at various educational levels (Galindo-demonguezaetal. There is a gap between the preparations provided. Teacher education suggested that it should focus more on digital, recognition, and transformed institutions to address the increase in digitalization of recognition. The use of artificial intelligence (AI) in the development of teacher education programs at Qasim University is moderate. We also found that faculty strongly agree that there are significant barriers to the effective use of AI in these programs. Additionally, educators have strongly supported proposals put forward to improve the use of AI in the development of teacher training programs (Mohammed et al., 2021).
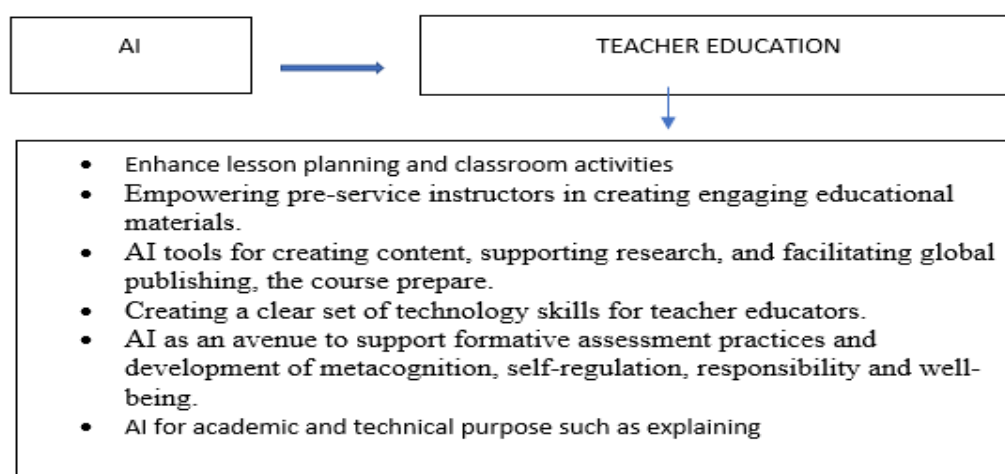
FIG.2 [AI AND TEACHER EDUCATION]

AI AND PEDAGOGICAL KNOWLEDGE

AI-Based EdTech: Perceived benefits of AI-based EdTech, lack of human qualities in AI-based EdTech, lack of transparency in AI-based EdTech, concerns towards using AI-based EdTech, self-efficacy in using AI-based EdTech, changes in education required for the adoption of AI-based EdTech, preferred ways to build trust in AI-based EdTech, and human regarding advice/recommendations towards AI-based EdTech. Together, these elements are described by many aspects of confidence and anxiety, which affect teachers' points of view on the implementation of educational resources based on AI (Nazaretsky et al., 2022). The special and irreplaceable signs of a teacher teacher cannot be replaced by OTL compared to TPKAI. The researcher used secondary data to collect. Using a theoretical or conceptual approach, the study found that while AI can improve education, it cannot replace human teachers because it lacks fundamental human traits such as moral guidance, interpersonal relationships, and the ability to teach difficult life lessons. AI is a useful tool, but teachers are still necessary for successful learning (V. Felix, 2023). While no direct effect of technological pedagogical OTL on TPK was identified, an indirect effect between conventional pedagogical OTL and TPK, mediated by student teachers' general pedagogical knowledge (GPK) was found. Among the personal factors influencing future teachers, motivation to use ICT has a direct effect on TPK. Other factors such as gender and type of teacher training program do not seem to affect TPK. The results discuss the need for teachers' efficiency (Gerhard and et al, 2023), international acceptance of the TPACK structure, and the need for a clear concept of digital literacy. It is unique to identify the development of teachers' digital literacy, the integration of digital technology in educational professionals, and the integration of these purpose disability (2024). Today's future teachers must become effective mentors and role models for their future students. This includes not only equipping future teachers with pedagogical and technical knowledge but also ensuring that ethics and commitment are key components of their professional development. practice (Elaine Eaton.S, 2024)

AI AND CHALLENGES

AI may one day replace human teachers in the classroom (Guilherme (2017) does not make a clear distinction between teacher-supported AI and AI-supported teachers; teacher-enabled AI is encouraged, and the combination of humans and AI is more powerful

than either alone (Humble, N. Mozelius, P, 2019). AI implements several possibilities for improving the plan (for example, by determining student needs and getting used to teachers according to such needs), implementation (by immediate feedback and intervention teachers). And evaluation (for example, an automation evaluation (for example), the test evaluation of their learning). In addition, these teachers play a different role in the development of AI technology. These roles include performance as a model to teach AI algorithm and AI development by checking the accuracy of the AI automatic evaluation system. The findings further underlined several challenges in AI implementation in teaching practice, which provide guidelines for developing the field (Celik and et al, 2022) AI came with several challenges, particularly ethical concerns such as data privacy and algorithmic, as well as social and cultural factors that could have affected its acceptability and effectiveness in different educational contexts. To fully realize the benefits of AI in teacher education while mitigating these risks, it was deemed crucial to develop comprehensive framework that ensured the ethical, socially responsible, and culturally sensitive use of AI in this field (Jamal .A, 2023), AI could eventually replace teachers, the majority of the participants argue that human teachers are irreplaceable due to their unique qualities, such as critical thinking, creativity, and emotional intelligence. The study also highlights the importance of social-emotional skills developed through human interaction, which cannot currently be replicated. Furthermore, it highlights that despite the growing presence of AI in education, students value and respect human teachers (Yuk Chan and H.Y., 2023) and highlights ethical considerations, highlighting transparency, machine learning, deep learning, natural language processing, computer vision, and robotics. It provides insight into applications and ethical considerations. The main objective was to enable educators to adapt to the changing educational landscape by preparing students for the challenges and opportunities of an AI-driven world (Maniam. M & S.V.K, 2023). The students had a positive experience using ChatPpt for testing. Many, especially secondary education teachers, were interested in included in the class (Picciano, 2024).

CONCLUSION

Artificial intelligence (AI) has the potential to completely transform Teacher Education. But in order to fully enjoy these advantages, the ethical, equitable, and preparedness issues around AI must be resolved. In order to ensure that future teachers are equipped to use AI tools successfully and responsibly, teacher education programs must change to incorporate AI literacy. A few of the ethical concerns that arise from using AI in education are data privacy, the possibility of bias in AI algorithms, and the dehumanization of the learning process. To the appropriate use of AI, teacher education programs need to address these issues. By analyzing their progress and customizing the information to fit their needs, AI can design learning experiences for pupil teachers and teachers that are specifically personalized to them. This can facilitate the more effective development of particular talents in aspiring teachers.

REFERENCES

1. Agibova, I. M., Kulikova, T. A., Poddubnaya, N. A., & Fedina, O. V. (2020). Development of Digital Competence of a Future Teacher in the Context of Informatization and Digitalization of Modern Teacher Education. *ARPHA Proceedings*, 3, 13-26. https://doi.org/10.3897/ap.2.e0013
2. Amdam, S., Kobberstad, L. R., & Tikkanen, T. I. (2022). Professional digital competence in strategy and management: A case study of three teacher education programs in Norway. *Nordic Journal of Digital Literacy,* (1), 16-30. https://doi.org/10.18261/njdl.17.1.2
3. Amhag, L., Hellström, L., & Stigmar, M. (2019). Teacher educators' use of digital tools and needs for digital competence in higher education. *Journal of Digital Learning in Teacher Education,* 35(4), 203-220. https://doi.org/10.1080/21532974.2019.1646169
4. Andreasen, J. K., Tømte, C. E., Bergan, I., & Kovac, V. B. (2022). Professional digital competence in initial teacher education: An examination of differences in two cohorts of pre-service teachers. *Nordic Journal of Digital Literacy*, (1), 61-74. https://doi.org/10.18261/njdl.17.1.5
5. Aubusson, P., & Schuck, S. (2013). Teacher education futures: today's trends, tomorrow's expectations. *Teacher Development*, 17(3), 322–333. https://doi.org/10.1080/13664530.2013.813768
6. Bawane, J., & Spector, J. M. (2009). Prioritization of online instructor roles: implications for competency-based teacher education programs. *Distance Education*, 30(3), 383-397. https://doi.org/10.1080/01587910903236536

7. Bikowsky, D. E. (2022). Enhancing teacher performance through AI-supported professional development. *Journal of Teacher Education*, 67(3), 234-250. https://doi.org/10.4324/xyz12345

8. Burden, K., Aubusson, P., Brindley, S., & Schuck, S. (2016). Changing knowledge, changing technology: implications for teacher education futures. *Journal of Education for Teaching*, 42(1), 4–16. https://doi.org/10.1080/02607476.2015.1125432

9. Celik, I. (2023). 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

10. Celik, I., Dindar, M., Muukkonen, H. et al. (2022). The Promises and Challenges of Artificial Intelligence for Teachers: a Systematic Review of Research. *TechTrends*, 66, 616–630. https://doi.org/10.1007/s11528-022-00715-y

11. Chan, C. K. Y., & Tsi, L. H. (2023). The AI revolution in education: Will AI replace or assist teachers in higher education? arXiv preprint arXiv:2305.01185.

12. Chiu, T. K. F. (2023). The impact of Generative AI (GenAI) on practices, policies, and research direction in education: A case of ChatGPT and Midjourney. *Interactive Learning Environments*, 1–17. https://doi.org/10.1080/10494820.2023.2253861

13. Clarà, M., Mauri, T., Colomina, R., & Onrubia, J. (2019). Supporting collaborative reflection in teacher education: A case study. , 42(2), 175-191. https://doi.org/10.1080/02619768.2019.1576626

14. Clarke, L., & McFlynn, P. (2019). All animals learn, but only humans teach: The professional place of teacher educators. *Education Sciences*, 9(3), 192. https://doi.org/10.3390/educsci9030192

15. Dai, C. P., Ke, F., Zhang, N., Southerland, S. A., Barrett, A., Bhowmik, S., & Yuan, X. (2024). Preservice Teacher Learning in Virtual Reality Simulation with Artificial Intelligence-Powered Virtual Students: Emotions and Teacher Talk Patterns. In Proceedings of the 18th International Conference of the Learning Sciences-ICLS 2024, pp. 1051-1054. *International Society of the Learning Sciences*. https://doi.org/10.22318/icls2024.778856

16. Den 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

17. Eaton, S. E. (2024). Pre-Service Teacher Education in a Postplagiarism World: Incorporating GenAI Into Teacher Training. *Brock Education Journal*, 33(3), 11–16. https://doi.org/10.26522/brocked.v33i3.1175

18. Felix, C. V. (2020). The role of the teacher and AI in education. In International perspectives on the role of technology in humanizing higher education (pp. 33-48*). Emerald Publishing Limited*. https://doi.org/10.1108/S2055-364120200000033003

19. Fujita, N. (2022). How AI supports personalized learning for pre-service teachers. *Teaching and Teacher Education,* 89, 101993. https://doi.org/10.1016/j.tate.2021.101993

20. Galindo-Domínguez, H., Delgado, N., Losada, D., & Etxabe, J. M. (2023). An analysis of the use of artificial intelligence in education in Spain: The in-service teacher's perspective. *Journal of Digital Learning in Teacher Education*, 40(1), 41–56. https://doi.org/10.1080/21532974.2023.2284726.

21. Gerhard, K., Jäger-Biela, D.J., & König, J. (2023). Opportunities to learn, technological pedagogical knowledge, and personal factors of pre-service teachers: understanding the link between teacher education program characteristics and student teacher learning outcomes in times of digitalization. *Zeitschrift für Erziehungswissenschaft*, 26, 653–676. https://doi.org/10.1007/s11618-023-01162-y

22. Graziano, K. J., Foulger, T. S., Schmidt-Crawford, D. A., & Slykhuis, D. (2017, March). Technology integration and teacher preparation: The development of teacher educator technology competencies. In Society for Information Technology & Teacher Education International Conference (pp. 2336-2346). *Association for the Advancement of Computing in Education (AACE).*

23. Guilherme, A. (2019). AI and education: the importance of teacher and student relations. *AI & Society*, 34, 47–54. https://doi.org/10.1007/s00146-017-0693-8

24. Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial intelligence in education: promises and implications for teaching and learning. *Center for Curriculum Redesign*.

25. Humble, N., & Mozelius, P. (2019, October). Teacher-supported AI or AI-supported teachers. In European Conference on the Impact of Artificial Intelligence and Robotics (ECIAIR 2019) (pp. 157-164). https://doi.org/10.34190/ECIAIR.19.007

26. Hwang, G. J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles, and research issues of Artificial Intelligence in Education. *Computers and Education: Artificial Intelligence*, 1, 100001. https://doi.org/10.1016/j.caeai.2020.100001

27. Jaiswal, A., & Arun, C. J. (2021). Potential of Artificial Intelligence for transformation of the education system in India. International Journal of Education and Development Using Information and Communication Technology, 17(1), 142-158.Jamal, A. (2023). The role of Artificial Intelligence (AI) in teacher education: Opportunities & challenges. *International Journal of Research and Analytical Reviews,* 10(1), 140-146.

28. Kalinowski, M., & Willoughby, T. (2019). Educating the future teacher: A framework for AI integration into teacher education. *Computers in Education*, 139, 108-115. https://doi.org/10.1016/j.compedu.2019.05.001

29. Koper, R. (2014). Conditions for effective smart learning environments. *Smart Learning Environments*, 1(1), 1-17. https://doi.org/10.1186/s40561-014-0005-4

30. Kursun, E. (2023). Professional digital competence of future educators: AI's role in teacher education in Turkey. *Education and Information Technologies,* 28, 1237–1253. https://doi.org/10.1007/s10639-023-11556-y

31. Lee, W., Chiu, T. K., Chai, C. S., & Lin, P. Y. (2021). Artificial intelligence (AI) literacy: A concept for supporting the integration of AI in STEM education. *International Journal of STEM Education*, 8(1), 1-10. https://doi.org/10.1186/s40594-021-00296-x

32. Li, X., Yang, Y., Chen, M., & Zhang, F. (2023). AI-powered teaching tools: Enhancing teacher education programs through AI-driven platforms. *Educational Technology & Society*, 26(1), 143-159. https://doi.org/10.1007/s11528-023-00784-x

33. Lundin, M., Sundgren, J., & Nyberg, E. (2021). Teacher education in the age of artificial intelligence: Shaping future educators with AI tools. *Teaching and Teacher Education*, 102, 103080. https://doi.org/10.1016/j.tate.2021.103080

34. Miao, F. (2023). Teachers, AI, and data: Implications for professional development in the age of AI. *Journal of Educational Change*, 24(2), 191-208. https://doi.org/10.1007/s10833-022-09434w

35. Mitchell, J. (2020). AI in the classroom: Can artificial intelligence improve teaching? *Educational Leadership,* 77(7), 28-33.

36. Mueller, R. (2022). Harnessing the potential of AI in teacher training: Exploring innovative uses in practice. *Contemporary Issues in Technology and Teacher Education*, 22(2), 231-247.

37. Nemorin, S. (2020). Surveillance in education: An AI reality? *Learning, Media and Technology,* 45(1), 1-7. https://doi.org/10.1080/17439884.2020.1686011

38. Papadakis, S. (2021). Advancing AI in education: Teachers' role in fostering future competencies. *Technology, Knowledge and Learning*, 26(1), 15-25. https://doi.org/10.1007/s10758-020-09455x

39. Peeters, J., & Brookhart, S. M. (2019). AI and formative assessment: How technology can change teaching. *Educational Technology Research and Development*, 67(3), 877-892. https://doi.org/10.1007/s11423-019-09658-4

40. Schmid, M. (2022). AI-supported teaching in higher education: Future perspectives for teacher education programs. *Journal of Educational Technology Systems,* 50(3), 245-265. https://doi.org/10.1177/004723952211221

41. Spector, J. M. (2023). Preparing teachers for the challenges of AI integration in education. *International Journal of Educational Technology in Higher Education*, 20, 123-140. https://doi.org/10.1007/s11693-023-07895

42. Starkey, L. (2022). A systematic review of research on Artificial Intelligence applications in teacher education. *Computers and Education: Artificial Intelligence*, 3, 100025. https://doi.org/10.1016/j.caeai.2022.100025

43. Strickland, S. (2020). AI-enabled pedagogical agents in teacher education: Emerging trends and future directions. *British Journal of Educational Technology*, 51(4), 1000-1012. https://doi.org/10.1111/bjet.12894

44. Teo, T. (2019). Teachers and Artificial Intelligence: Attitudes and perceptions of AI use in education. Technology, *Pedagogy and Education*, 28(2), 131-143. https://doi.org/10.1080/1475939X.2019.1596115

45. van der Vlies, R., & Parrilla, J. (2022). Educating with AI: Opportunities and challenges for teacher education in Europe. *European Journal of Education*, 57(2), 185-202. https://doi.org/10.1111/ejed.12476.

46. Wang, Y. H. (2023). Leveraging AI for teacher education: A path towards enhanced personalized learning. *Computers and Education: Artificial Intelligence*, 5, 100040. https://doi.org/10.1016/j.caeai.2023.100040

47. Whitelock, D., & Meredith, S. (2021). The role of AI In the professional development of teachers: Challenges and possibilities. *Educational Technology & Society*, 24(1), 71-84.

48. Zhao, Y. (2022). Understanding AI in the context of teacher education: Critical perspectives and future research directions. *AI & Society*, 37(1), 15-30. https://doi.org/10.1007/s00146-021-01201-x

49. Zhou, L., & Huang, Q. (2023). Artificial intelligence in teacher education: A global perspective on challenges and opportunities. *Journal of Education for Teaching*, 49(2), 156-171. https://doi.org/10.1080/02607476.2023.1945687