



Pre-Service Elementary Teachers' Attitudes and Utilisation of Artificial Intelligence in Academic Activities

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Abstract

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Artificial intelligence (AI) is transforming education rapidly. However, awareness of AI and its utilization varies significantly across professional fields and educational levels. This study investigated pre-service teachers' attitudes towards and use of AI in teaching and learning activities in Nigeria. A descriptive survey method was employed involving 96 pre-service teachers from a private college of education in Kwara State who were selected via simple random sampling. Data were collected using the Pre-service Elementary Teachers' Attitudes and Utilization of Artificial Intelligence in Teaching-Learning Activities Questionnaire (PSETAUAIQ), which demonstrated strong reliability (index = 0.77). The findings were insightful: Pre-service teachers consistently expressed positive attitudes towards integrating AI into their teaching, and the study revealed a high level of AI utilization among them. Crucially, analysis confirmed no significant difference in attitudes or AI utilization based on gender. Based on these results, it is strongly recommended that pre-service teachers receive comprehensive ethical training to ensure the responsible and effective use of AI tools in their future classrooms.

INTRODUCTION

Background of the Study

The attitudes of pre-service elementary teachers towards the use of artificial intelligence (AI) in academic activities, and their actual use of it, significantly influence their preparedness for integrating advanced technologies in classroom settings. According to Guan et al. (2025), pre-service teachers' willingness to embrace AI correlates with their perceived benefits in enhancing educational outcomes. Recent studies underscore the growing interest among pre-service elementary teachers in incorporating AI into their teaching practices. For instance, Lucas et al. (2025) and Morales-Cavellos et al. (2025) revealed that many aspiring teachers recognize AI's potential to enhance instructional strategies and student engagement, fostering personalized learning experiences. Furthermore, Vartiainen et al. (2025) highlight that pre-service teachers increasingly perceive AI as a means to support differentiated instruction and provide timely feedback to students, which they see as essential for promoting learning equity and academic success. However, pre-service teachers often express

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apprehensions about their preparedness to use AI effectively and its potential impact on traditional teaching methods (Arya & Verma, 2024). These concerns highlight the need for targeted training and support to empower educators to leverage AI while addressing perceived challenges. Structured training programs can significantly improve teachers' competence using AI tools for personalised learning and data analysis and mentorship programs can guide teachers through integrating AI into curriculum planning and instructional design (Ayanwale et al., 2025; Merzifonluoglu & Gunes, 2025).

Problem of the Study

Integrating artificial intelligence (AI) into the educational environment presents opportunities and challenges, particularly regarding pre-service teachers' attitudes towards and use of AI to enhance academic activities. It is crucial to understand how these educators perceive and adopt AI technology to inform effective strategies in teacher preparation programmes. While educators recognise AI's capacity to personalize the learning experience and provide data-driven insights (Choi, 2025). Concerns regarding technological competence and ethical implications persist. Adigun et al., (2025) emphasise the importance of assessing educators' attitudes towards AI to effectively prepare them. Erdem-Coşgun, (2025) and Laru et al. (2025) note that some educators express concerns about AI's implications for pedagogical autonomy and student-teacher relationships (Bae et al., 2025). Additionally, differences in institutional policies, acts, and support structures can significantly influence the adoption of AI in education (Ayanwale et al., 2025; Görtl et al., 2025).

Research's State of the Art

There is a growing interest among pre-service elementary teachers in incorporating AI into their teaching practices (Sanusi et al., 2024; Sperling et al., 2024), with many aspiring teachers viewing AI as a tool to enhance personalized learning experiences, improve student engagement, and provide targeted interventions tailored to individual student needs (Powell & Courchesne, 2024). Wang et al. (2024) found that teachers' technological readiness and familiarity with AI tools significantly impact their attitudes and willingness to integrate AI into teaching practices. Providing adequate training and support in AI technologies could enhance educators' confidence and readiness to use these tools effectively (Markos et al., 2024). Research by Uzunboylu et al. (2025) highlights changes in teachers' and prospective teachers' attitudes after training on interactive learning tools, addressing an often-overlooked aspect of educational technology adoption. This contrasts with previous research, primarily focused on Web 2.0 tool usage and effectiveness without specifically examining attitude changes post-training. Furthermore, Alejandro et al. (2024) and Kalnina et al. (2024), highlight the effect of blended learning on the numerical ability and learning creativity of high school students, a less explored area compared to previous research that focused more on higher education, critical thinking, and learning independence.

Gap Study and Objective

Despite the growing recognition of AI's potential and existing research on technology adoption, a comprehensive understanding of pre-service teachers' specific attitudes towards and utilization of AI in the Nigerian context remains elusive. While previous studies have addressed various aspects of educational technology, there is limited research observing the impact of dedicated training on modern interactive tools or blended learning on the attitudes and competencies of future educators within this distinct demographic. This study aims to address this issue by examining the factors that influence pre-service elementary teachers' attitudes towards AI, with a particular focus on their perceived benefits and concerns, as well as their actual utilization of AI in academic activities in Nigeria. By understanding and addressing these factors, educational stakeholders can facilitate a smoother integration of AI into teacher preparation programs, thereby equipping future educators to harness its transformative potential effectively (Laru et al., 2024). The objective is to provide insights that can inform targeted training and supportive policies, enhancing educators' technological readiness and fostering an environment in which AI can improve teaching quality and student learning outcomes seamlessly.

METHOD

Type and Design

This study employed a descriptive survey research design Guan et al. (2025) and Laru et al. (2024) to investigate pre-service teachers' attitudes towards, and use of, artificial intelligence (AI) in teaching and learning activities. This design was chosen for its suitability in collecting self-reported data via questionnaires, which was essential for achieving the study's aim.

Data and Data Sources

The study population comprised all pre-service teachers from a College of Education in Kwara State, Nigeria. Specifically, the target population was final-year elementary pre-service teachers who had used technological materials for their projects and assignments. Of these, 96 were selected at random. These participants were drawn from the School of Education's Department of Early Childhood and Primary Education and the School of Arts and Social Science Education. In Nigeria, colleges of education are responsible for training teachers at the primary level.

Data Collection Technique

The primary instrument for data collection was a researcher-designed questionnaire titled 'Pre-service Elementary Teachers' Attitudes and Utilization of Artificial Intelligence in Teaching and Learning Activities Questionnaire' (PSETAUAIQ). The PSETAUAIQ consisted of three sections: Section A gathered demographic information about the respondents; Section B contained five items measuring their attitudes towards using artificial intelligence in teaching and learning activities; and Section C comprised five items assessing their use of artificial intelligence in these activities. The instrument adopted a four-point Likert scale, with response options ranging from 4 (strongly agree) to 1 (strongly disagree).

The face and content validity of the PSETAUAIQ were established by two expert lecturers from the Department of Adult and Primary Education at the University of Ilorin's Faculty of Education. Their suggestions were used to refine the final version. The instrument's reliability was determined using the test-retest method in a pilot study involving 20 education students from a different college of education whose characteristics were similar to those of the actual respondents. Pearson's Moment Correlation Coefficient was used for the analysis, yielding a reliability index of $r = 0.77$ and confirming the instrument's reliability for data collection. Questionnaires were distributed to respondents via Google Forms to ensure voluntary participation and informed consent, and all completed questionnaires were retrieved electronically.

Data Analysis

The collected data were analyzed using SPSS software. Descriptive statistics (mean, frequency and percentage) were used to analyse the demographic information and answer the research questions. An independent sample t-test was used for hypothesis testing at a significance level of 0.05.

RESULTS

This section provides an overview of the demographics of the study's participants. It is important to understand how participants are distributed by gender, age and school in order to interpret the characteristics of the sample and the context of the findings. This demographic data is also relevant when addressing research questions or hypotheses that consider these variables, such as whether there are differences in AI attitudes or utilization based on gender or age.

Table 1. Demographics distributions of respondents based on Gender, Age, and School

Variable	Frequency	Percentage
Gender		
Male	38	39.6
Female	58	60.4
Age		
18-24 years	29	30.2
25-30 years	48	50.0

Variable	Frequency	Percentage
31 and above	19	19.8
School		
Education	30	31.3
Arts and Social Sciences	44	45.8
Science	22	22.9
Total	96	100.0

Table 1 shows the demographic breakdown of respondents by gender, age, and school. Of the 96 pre-service teachers who participated in the study, 38 (39.6%) were male and 58 (60.4%) were female. This implies that the study comprises both male and female respondents, although more female pre-service teachers participated. The results also reveal the demographic distribution of respondents based on age. Table 1 shows that most of the respondents (48, or 50.0%) were aged 25–30, 29 (30.2%) were aged 18–24, and 19 (19.8%) were aged 31 and over. The results also revealed the demographic distribution of respondents by school. The majority of respondents, 44 (45.8%), were from the School of Art and Social Science; 30 (31.3%) were from the School of Education; and 22 (22.9%) were from the School of Science.

Research question one: What are pre-service elementary teachers' attitudes towards artificial intelligence in teaching and learning activities?

Table 2. Mean and Rank order of pre-service elementary teachers' Attitudes toward artificial intelligence in teaching-learning activities

S/N	Item	Mean	Rank
1	Artificial intelligence improves instruction and learning	3.39	1 st
2	I believe that Artificial intelligence can help students personalize learning activities	3.25	4 th
3	Artificial intelligence can help pre-service teachers reduce academic stress by automating tasks	3.30	3 rd
4	I am confident that Artificial intelligence can be integrated into future teaching and learning activities	3.36	2 nd
5	I am confident that Artificial intelligence can improve student and teacher engagement in the classroom	3.19	5 th
6	The introduction of Artificial intelligence helps to develop students' level of thinking	3.08	6 th
	Weighted Mean	3.26	

Fieldwork: 2025. Cut off mean: 2.50

Table 2 above shows the mean scores and rank order of pre-service elementary teachers' attitudes towards the use of artificial intelligence in teaching and learning activities. The respondents' responses varied, with items 1 and 6, "Artificial intelligence improves instruction and learning", and 4, "I am confident that artificial intelligence can be integrated into future teaching and learning activities", ranking highest with mean scores of 3.39 and 3.36, respectively. Item 3, "Artificial intelligence can help pre-service teachers reduce academic stress by automating tasks", ranked third with a mean score of 3.30, followed by item 2, "I believe that artificial intelligence can help students to personalize learning activities", with a mean score of 3.25; followed by item 5, "I am confident that artificial intelligence can improve student and teacher engagement in the classroom", with a mean score of 3.19; and the lowest rank was item 6, "The introduction of artificial intelligence helps to develop students' level of thinking", with a mean score of 3.08. The average mean score of 3.26 is higher than the weighted mean score of 2.50, which is the benchmark for determining pre-service teachers' attitudes towards the use of artificial intelligence in teaching and learning activities. This implies that pre-service teachers have a positive attitude towards the use of artificial intelligence in teaching and learning activities.

Research question two: what is the level of artificial intelligence utilization among pre-service elementary teachers?

Table 3. Mean and Rank order of the level of artificial intelligence utilisation among pre-service elementary teachers

S/N	Item	Mean	Rank
1	I often utilise artificial intelligence (ChatGPT et al., etc.)	3.17	2 nd
2	I use Artificial intelligence tools for my projects and seminars	3.10	3 rd
3	I often utilised Artificial Intelligence tools to improve my teaching practice experience	3.08	4 th
4	I often utilised Artificial intelligence for my personal and professional development	3.18	1 st
5	I often use Artificial Intelligence for Editing, creating PowerPoint presentations, and creating images	2.91	5 th
Weighted Mean		3.09	

Fieldwork: 2025. Cut off mean: 2.50

Table 3 above shows the mean and rank order of the level of artificial intelligence utilization among pre-service primary school teachers. The respondents' responses varied and were ranked accordingly. Item 4, "I often utilize artificial intelligence for my personal and professional development", with a mean score of 3.18, was ranked first, followed by Item 1, "I often utilize artificial intelligence (ChatGPT et al.), etc." with a mean score of 3.17, ranked second; item 2, "I use artificial intelligence tools for my projects and seminars," with a mean score of 3.10, ranked third; item 3, "I often use artificial intelligence tools to improve my teaching practice experience," with a mean score of 3.08, ranked fourth; and item 5, "I often use artificial intelligence for editing, creating PowerPoint presentations, and creating images," with a mean score of 2.91, ranked last. The weighted mean of 3.09 is greater than the benchmark of 2.50, the cut-off point for determining the level of AI utilization among pre-service elementary teachers. Based on these values, it can be concluded that the level of AI utilisation among pre-service elementary teachers is high.

Research hypothesis one: There is no significant difference in pre-service elementary teachers' attitudes towards artificial intelligence in teaching and learning activities based on gender.

Table 4. Summary of Independent Sample T-test on pre-service elementary teachers' Attitudes Towards Artificial Intelligence in teaching-learning activities based on Gender

Gender	No	Mean	SD	Df	T-value	Sig
Male	38	19.82	1.753	94	1.07	.288
Female	58	19.41	1.8357			

Table 4 shows that $t(96) = 1.07$ is not significant at the 0.05 level. As the significant value of 0.288 is greater than the level of significance of 0.05, the null hypothesis that there is no significant difference among pre-service elementary teachers is accepted. Attitudes towards the use of artificial intelligence in teaching and learning activities were not found to differ based on gender. This implies that there is no significant difference in attitudes towards artificial intelligence in teaching and learning activities among pre-service elementary teachers based on gender.

Research Hypothesis Two: There is no significant difference in the level of artificial intelligence utilization among pre-service elementary teachers based on gender.

Table 5. Summary of Independent Sample T-test on pre-service elementary teachers' level of artificial intelligence utilisation among pre-service teachers based on Gender

Gender	No	Mean	SD	Df	T-value	Sig
Male	38	15.61	2.1503	94	.560	.577
Female	58	15.34	2.2754			

Table 5 shows that $t(96) = 0.560$ is not significant at the 0.05 level. Since the value of 0.577 is greater than the level of significance of 0.05, the null hypothesis that there is no significant difference in the level of artificial intelligence utilization among pre-service elementary teachers based on gender is accepted. The null hypothesis that there is no significant difference in the level of artificial intelligence utilization among pre-service elementary teachers based on gender was not rejected. This implies that there is no significant difference in the level of artificial intelligence utilization among pre-service elementary teachers based on gender.

DISCUSSIONS

This study investigated pre-service elementary teachers' attitudes towards and use of artificial intelligence (AI) in teaching and learning activities, as well as any potential gender differences. The findings provide significant insights into the integration of AI in teacher training programmes in Nigeria, offering a robust basis for comparison with existing international literature. The findings also highlight crucial areas for future development and policy implementation.

Attitudes Towards Artificial Intelligence

The analysis revealed that pre-service elementary teachers predominantly view the integration of AI into teaching and learning activities positively. This positive outlook is primarily driven by their perception that AI can effectively tailor learning experiences to students' individual needs, accommodating diverse learning styles and paces. This feature is highly valued for its potential to enhance student outcomes and promote personalized education (Adigun et al., 2025). This finding aligns strongly with a growing body of international research. For example, Xue and Wang (2022) found that teachers also had positive attitudes towards AI in educational settings (Xue & Wang, 2022), affirming its potential to reduce workload, improve digital literacy and facilitate continuous professional development. Similarly, Bae et al. (2024) and Göttl et al. (2024), observed high acceptability and positive attitudes towards AI among science teachers in Abu Dhabi schools, highlighting a global trend of openness to AI in education. Pokrivcakova (2024) corroborated this further by reporting positive attitudes among pre-service teachers towards integrating AI into English as a Foreign Language (EFL) teaching and learning (Pokrivcakova, 2024), specifically noting its perceived benefits for language acquisition. Furthermore, these results are consistent with those of Tovar and Ocegueda (2025), who also emphasized positive teacher attitudes towards AI and its capacity to simplify complex tasks, improve ease of use and foster collaborative lessons among students (Tovar & Ocegueda, 2025). This positive sentiment among pre-service teachers reflects a global trend of modernizing teaching methods and highlights their proactive interest in using AI to optimize learning processes and improve student outcomes, while addressing individual differences. This enthusiasm further accentuates the critical significance of ongoing professional development initiatives in the domain of AI for educators.

However, it is important to acknowledge that these overwhelmingly positive findings do not entirely align with Markos et al., (2024) submission, which reported negative attitudes among educators towards AI tools used by learners for completing assignments. This apparent discrepancy requires careful consideration of the specific AI applications being evaluated and contextual factors. In Yang's study, the negative attitude could likely be attributed to concerns about academic integrity and over-reliance on technology at the expense of critical thinking (Guan et al., 2025). There is also a perceived lack of proper guidance for students on how to use AI effectively and ethically. In contrast, our study's participants, who are pre-service teachers, likely perceive AI more as a powerful pedagogical tool for their own professional development, classroom management, and instructional

design than as a tool solely for student assignments. Therefore, the positive attitude observed in our study may reflect their proactive interest in using AI to enhance their professional capabilities, streamline administrative tasks and optimize instructional delivery. This comparison highlights a crucial distinction: while the use of AI by students without proper oversight can evoke apprehension, its judicious application as a teaching aid is generally welcomed by aspiring educators. This emphasizes the vital need for educators to possess the knowledge and skills to effectively guide students in the ethical and beneficial utilization of AI, thereby transforming potential concerns into constructive, pedagogically sound engagement.

Utilisation of Artificial Intelligence

The study's findings also robustly indicated a high level of AI utilization among pre-service elementary teachers. This suggests that these teachers already possess commendable proficiency in integrating AI into their educational practices, indicating a positive trajectory for future classroom environments (Ayanwale et al., 2025; Merzifonluoglu & Gunes, 2025). This observation is consistent with the findings of Bae et al., (2025) who noted a significant increase in the use of AI tools in lesson planning and classroom activities by pre-service elementary teachers. This points to the progressive and widespread adoption of AI technologies in educational settings. Furthermore, Kalnina et al. (2024), observed a significant correlation between pre-service elementary teachers' early exposure to AI technologies during their training and their subsequent practical use of AI in educational contexts (Choi, 2025). This emphasizes the importance of foundational exposure and targeted training in fostering robust AI proficiency. Our findings align perfectly with those of Erdem-Coşgun, (2025) and Laru et al. (2025), who also revealed that pre-service teachers have positive perceptions of AI and use it extensively in various educational activities. Similarly, Guan et al. (2025), found that exposure to TPACK (Technological Pedagogical Content Knowledge) courses positively improved teachers' acceptance and utilization of artificial intelligence in their investigations of teachers who participated in such courses. This finding reinforces the link between structured training and practical application.

However, this finding diverges markedly from that of Gatlin (2023), who reported relatively low exposure to AI among pre-service teachers, consequently leading to low utilization rates. This disparity could be attributed to several factors, including differences in institutional support mechanisms, the design and flexibility of the curriculum, and varying levels of access to the necessary technological infrastructure in different educational contexts and geographical regions. In the context of our study, the high utilization observed suggests that pre-service teachers are actively leveraging a diverse array of AI tools for various pedagogical tasks. This includes streamlining lesson preparation, developing and administering formative and summative assessments, providing personalized feedback to students and engaging in continuous professional development through AI-powered learning platforms. This active and diverse engagement with AI enhances their instructional efficiency and significantly develops their broader technological competencies, positioning them as highly adaptable and innovative educators who are prepared for the dynamic demands of modern classrooms.

Gender Differences in Attitudes and Utilisation

A crucial finding of this study was that there were no significant differences in the attitudes and utilization of AI in teaching-learning activities of pre-service elementary teachers based on gender. This robust outcome strongly implies that male and female pre-service teachers have remarkably similar perceptions of, levels of engagement with, and practical applications for AI in their professional development. This finding is consistent with the conclusions of Islahi and Nasr (2019), who found that teachers' attitudes towards using technology in teaching are not gender-specific. This suggests that all educators should be expected to use technology effectively in the classroom, regardless of their gender. This consistency suggests that the perceived value and practical integration of AI transcend traditional gender boundaries in education.

However, this finding does not align entirely with that of Sanusi et al., (2024) and Sperling et al., (2024), who investigated AI acceptance among pre-service teachers and identified a significant gender difference concerning the perceived 'ease of use' of AI. While Zhang's study identified nuanced differences in a single dimension, ease of use, our study's broader assessment of overall attitude and

utilization suggests that minor perceptual differences do not necessarily translate into significant disparities in overall adoption or general sentiment towards AI (Laru et al., 2024). This implies that even if specific technical aspects of AI are perceived differently by gender, readiness and willingness to integrate AI into teaching practices are consistently high across male and female cohorts. This finding further reinforces the critical notion that institutional efforts to promote AI literacy, provide access to AI tools and offer comprehensive training should benefit all pre-service teachers equally. This approach mitigates the need for gender-specific interventions, ensuring equitable opportunities and fostering a uniformly capable teaching workforce prepared to harness AI's full potential.

CONCLUSION

The findings of this study confirm that pre-service primary school teachers have a positive attitude towards artificial intelligence (AI) and use it extensively in teaching and learning activities. No significant gender-based differences were observed. This highlights their preparedness to adopt advanced technologies in contemporary educational environments. This research makes a significant contribution to the field by providing up-to-date, specific empirical evidence on the attitudes towards and use of AI among pre-service elementary school teachers in Nigeria. Unlike much of the existing literature, which tends to focus on technology adoption or teachers' general perceptions of AI, this study specifically examines the preparedness of future primary school educators in the context of a developing nation. The finding that these pre-service teachers already possess a high level of AI proficiency and a positive attitude towards it, irrespective of gender, is a notable novel finding. This suggests that the next generation of educators is more receptive to, and capable of integrating, AI than previously thought, challenging the idea that there is widespread technophobia in education. It contributes to our evolving understanding of how AI is perceived and adopted at the grassroots level of teacher training, thereby enriching the current body of knowledge on the integration of educational technology and offering valuable insights for policy formulation. This study provides valuable insights but has limitations, as it was conducted in only one College of Education in Kwara State, Nigeria, which restricts the generalizability of the findings. The reliance on self-reported questionnaire data may also introduce bias and fail to capture the complexities of actual AI implementation. Future research should involve more diverse samples, adopt longitudinal designs, and integrate qualitative methods such as interviews or classroom observations for deeper understanding. The findings have important implications for educational stakeholders and teacher training programs, particularly in strengthening practical training in AI. Institutions and policymakers should strategically integrate AI into teacher education curricula to build advanced competencies beyond basic digital literacy. Continuous professional development on AI integration should also be provided to in-service teachers to ensure sustained adoption and innovation. These efforts will better prepare educators for 21st-century teaching demands and address the increasingly complex learning needs of students.

REFERENCES

- Adigun, O. T., Tijani, F. A., Haihambo, C. K., & Enock, S. L. (2025, February). Understanding pre-service teachers' intention to adopt and use artificial intelligence in Nigerian inclusive classrooms. In *Frontiers in Education* (Vol. 10, p. 1519472). Frontiers Media SA. <https://doi.org/10.3389/feduc.2025.1519472>
- Alejandro, I. M. V., Sanchez, J. M. P., Sumalinog, G. G., Mananay, J. A., Goles, C. E., & Fernandez, C. B. (2024). Pre-service teachers' technology acceptance of artificial intelligence (AI) applications in education. *STEM Education*, 4(4), 445-465. <https://doi.org/10.3934/steme.2024024>
- Arya, N. R., & Verma, N. A. (2024). Role of artificial intelligence in education. *International Journal of Advanced Research in Science Communication and Technology*, 589-594. <https://doi.org/10.48175/ijarsct-19461>
- Ayanwale, M. A., Adelana, O. P., Molefi, R. R., Adeeko, O., & Ishola, A. M. (2024). Examining artificial intelligence literacy among pre-service teachers for future classrooms. *Computers and education open*, 6, 100179. <https://doi.org/10.1016/j.caeo.2024.100179>

- Ayanwale, M. A., Frimpong, E. K., Opesemowo, O. A. G., & Sanusi, I. T. (2025). Exploring factors that support pre-service teachers' engagement in learning artificial intelligence. *Journal for STEM Education Research*, 8(2), 199-229. <https://doi.org/10.1007/s41979-024-00121-4>
- Bae, H., Hur, J., Park, J., Choi, G. W., & Moon, J. (2024). Pre-Service Teachers' Dual Perspectives on Generative AI: Benefits, Challenges, and Integration into Their Teaching and Learning. *Online Learning*, 28(3), 131-156. <https://doi.org/10.24059/olj.v28i3.4543>
- Choi, Y. S. (2025). Earth science simulations with Generative Artificial Intelligence (GenAI). *Journal of University Teaching and Learning Practice*, 22(1), 1–24. <https://search.informit.org/doi/10.3316/informit.T2025022500016390939527540>
- Erdem-Coşgun, G. (2025). Artificial intelligence literacy in assessment: Empowering pre-service teachers to design effective exam questions for language learning. *British Educational Research Journal*. <https://doi.org/10.1002/berj.4177>
- Gatlin, M. (2023). Assessing pre-service teachers' attitudes and perceptions of using artificial intelligence in the classroom. *Texas Educator Preparation*, 7(2), 1–8. <https://doi.org/10.59719/txep.v7i2.35>
- Görtl, K., Ambros, R., Dolezal, D., & Motschnig, R. (2024). Pre-service teachers' perceptions of their digital competencies and ways to acquire those through their studies and self-organized learning. *Education Sciences*, 14(9), 951. <https://doi.org/10.3390/educsci14090951>
- Guan, L., Zhang, Y., & Gu, M. M. (2025). Pre-service teachers preparedness for AI-integrated education: An investigation from perceptions, capabilities, and teachers' identity changes. *Computers and Education: Artificial Intelligence*, 8, 100341. <https://doi.org/10.1016/j.caeai.2024.100341>
- Islahi, F., & Nasrin (2019). Exploring Teacher Attitude towards Information Technology with a Gender Perspective. *Contemporary Educational Technology*, 10(1), 37-54. <https://doi.org/10.30935/cet.512527>
- Kalniņa D, Nīmanīte D and Baranova S (2024) Artificial intelligence for higher education: benefits and challenges for pre-service teachers. *Front. Educ.* 9:1501819. <https://doi.org/10.3389/feduc.2024.1501819>
- Laru, J., Celik, I., Kivioja, I., & Mäkitalo, K. (2024). Learning AI Literacy in Collaborative Projects with an AI Education Tool by Making Machine-Learning-Driven Apps: A Case Study from Finnish Pre-service Teacher Education. In *Effective Practices in AI Literacy Education: Case Studies and Reflections* (pp. 141-149). Emerald Publishing Limited. <https://doi.org/10.1108/978-1-83608-852-320241015>
- Lucas, M., Bem-haja, P., Zhang, Y., Llorente-Cejudo, C., & Palacios-Rodríguez, A. (2025). A comparative analysis of pre-service teachers' readiness for AI integration. *Computers and Education: Artificial Intelligence*, 8, 100396. <https://doi.org/10.1016/j.caeai.2025.100396>
- Markos, A., Prentzas, J., & Sidiropoulou, M. (2024). Pre-Service teachers' assessment of ChatGPT's utility in higher education: SWOT and content analysis. *Electronics*, 13(10), 1985. <https://doi.org/10.3390/electronics13101985>
- Merzifonluoglu, A., & Gunes, H. (2025). Shifting Dynamics: Who Holds the Reins in Decision-Making With Artificial Intelligence Tools? Perspectives of Gen Z Pre-Service Teachers. *European Journal of Education*, 60(1), e70053. <https://doi.org/10.1111/ejed.70053>
- Morales-Cevallos, M. B., Alonso-García, S., Martínez-Menéndez, A., & Victoria-Maldonado, J. J. (2025). Artificial Intelligence Adoption Amongst Digitally Proficient Trainee Teachers: A Structural Equation Modelling Approach. *Social Sciences*, 14(6), 355. <https://doi.org/10.3390/socsci14060355>
- Pokrivcakova, S. (2023). Pre-service teachers' attitudes towards artificial intelligence and its integration into EFL teaching and learning. *Journal of Language and Cultural Education*, 11(3), 2023. 100-114. <https://doi.org/10.2478/jolace-2023-0031>

- Powell, W., & Courchesne, S. (2024). Opportunities and risks involved in using ChatGPT to create first grade science lesson plans. *PLoS one*, 19(6), e0305337. <https://doi.org/10.1371/journal.pone.0305337>
- Sanusi, I. T., Ayanwale, M. A., & Tolorunleke, A. E. (2024). Investigating pre-service teachers' artificial intelligence perception from the perspective of planned behavior theory. *Computers and Education: Artificial Intelligence*, 6, 100202. <https://doi.org/10.1016/j.caeai.2024.100202>
- Sperling, K., Stenberg, C. J., McGrath, C., Åkerfeldt, A., Heintz, F., & Stenliden, L. (2024). In search of artificial intelligence (AI) literacy in teacher education: A scoping review. *Computers and Education Open*, 6, 100169. <https://doi.org/10.1016/j.caeo.2024.100169>
- Tovar, I. Z., & Ocegueda, G. J. R. G. (2025). Attitudes of university professors towards the use of artificial intelligence in teaching and learning. *International Journal Of Multidisciplinary Research And Analysis*, 08(01). <https://doi.org/10.47191/ijmra/v8-i01-46>
- Uzunboylyu, H., Belassarova, Z., Yermekbayev, M., Shadiyeva, N., Zhamasheva Z., Uaidullakyzy, E., & Nurgali, S. (2025). Teacher training for interactive learning tools and determining their attitudes. *Journal of Distance Education (RED)*, 25 (81). <https://doi.org/10.6018/red.616831>
- Vartiainen, H., Liukkonen, P., & Tedre, M. (2025). Emerging human-technology relationships in a co-design process with generative AI. *Thinking Skills and Creativity*, 56, 101742. <https://doi.org/10.1016/j.tsc.2024.101742>
- Wang, K., Ruan, Q., Zhang, X., Fu, C., & Duan, B. (2024). Pre-service teachers' GenAI anxiety, technology self-efficacy, and TPACK: Their structural relations with behavioral intention to design GenAI-assisted teaching. *Behavioral Sciences*, 14(5), 373. <https://doi.org/10.3390/bs14050373>
- Xue, Y., & Wang, Y. (2022). Artificial intelligence for education and teaching. *Wireless Communications and Mobile Computing*, 1–10. <https://doi.org/10.1155/2022/4750018>