



*Evaluation of Artificial Intelligence Tools Integration among ... Musa, H. R., Et. al. (2026)*

## **Evaluation of Artificial Intelligence Tools Integration among Pre- Service Biology Teachers: A Case Study of Federal University of Education, Zaria, Kaduna State, Nigeria**

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### **Abstract**

*The study evaluated the integration of artificial intelligence (AI) tools among in pre-service Biology teachers in Federal University of Education, Zaria Kaduna State. The study was guided by four research objectives with corresponding research questions and null hypotheses, respectively. A descriptive survey research design was used for the study. The population of the study were all pre-service Biology students during the 2024/2025 academic session in Federal University of Education, Zaria, Kaduna State. A sample size of 225 pre-service Biology students were selected from the target population using simple random sampling technique. Data were collected using a structured instrument titled Challenges and Opportunities of Artificial Intelligence in Pre-service Biology Teacher Education Questionnaire (COAIPBTEQ) with a reliability coefficient of 0.88. inferential statistics (t-test) were used to test the null hypotheses. Findings of the study revealed that there was no statistically significant relationship between the level of awareness and the use of AI tools among pre-service Biology teachers ( $r = -0.101, p > 0.05$ ). However, a significant difference was found between institutions with high and low levels of support for AI integration ( $p < 0.05$ ). Additionally, a significant gender difference was observed in AI tool usage ( $p < 0.05$ ), with male students showing higher usage rates than their female counterparts. Based on these findings, the study recommends that the government and educational institutions, such as the Federal University of Education, Zaria, invest in digital infrastructure, including reliable internet connectivity, smart classrooms, and AI-enabled platforms, to enhance the integration and effective use of AI in teacher education.*

**Keywords:** Artificial Intelligence Tools, Pre-service Biology Teachers, Federal University of Education Zaria

### **Introduction**

The integration of Artificial Intelligence (AI) into teacher education has rapidly transformed pedagogical practices across disciplines, including science education. In particular, Biology, a subject deeply rooted in empirical inquiry and conceptual visualization, stands to benefit significantly from AI-enhanced learning environments. Pre-service teacher education, which prepares student-teachers for the complexities of real-world classrooms, now faces the imperative of equipping future Biology educators with the technological competence and pedagogical flexibility needed to navigate AI-driven educational tools (Suryawanshi et al., 2023; Zhang et al., 2022). Artificial Intelligence, encompassing technologies such as machine learning, natural language processing, and intelligent tutoring systems, offers immense potential in Biology education. AI tools



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can enhance visualization of complex biological processes, provide real-time feedback through adaptive learning platforms, and simulate laboratory environments for experiential learning (Chukwudi & Kalu, 2020; Okonkwo et al., 2022). These tools not only support differentiated instruction but also foster independent inquiry and critical thinking skills, which are central to Biology pedagogy. Moreover, AI can assist pre-service Biology teachers in lesson planning, automated assessment, and classroom management, thereby improving their instructional efficiency and confidence (Obielodan et al., 2023; Shu & Guo, 2021). Despite these opportunities, the integration of AI in pre-service Biology teacher education faces several challenges. One major concern is the limited access to AI infrastructure and tools, especially in developing contexts such as sub-Saharan Africa, where teacher education programs often lack sufficient funding and digital resources (Ede & Ndudi, 2019; Uchenna & Mohammed, 2021). Additionally, many teacher training institutions have not fully integrated AI competencies into their curricula, resulting in gaps in technological pedagogical content knowledge (TPACK) among student-teachers (Olalekan & Salami, 2022). Another challenge is the resistance to change due to lack of awareness, technical expertise, or institutional support, which can hinder the effective adoption of AI in teacher preparation programs (Afolabi & Odeyemi, 2021; Alhassan & Nwokedi, 2023). Ethical concerns also emerge with the adoption of AI in education. Issues such as data privacy, algorithmic bias, and over-reliance on technology present critical risks that pre-service Biology teachers must be trained to recognize and navigate (Yakubu & Bello, 2023; UNESCO, 2021). These challenges underscore the need for teacher education programs to adopt a balanced and critical approach to AI integration—one that not only emphasizes technological skills but also fosters reflective practice and ethical awareness. Nonetheless, the opportunities for innovation and transformation in Biology teacher education are profound. Integrating AI can bridge gaps in instructional delivery, particularly in contexts with teacher shortages or limited laboratory infrastructure (Ajayi et al., 2020). AI-driven platforms can personalize learning for pre-service teachers, allowing them to progress at their own pace and revisit difficult content areas. Furthermore, AI can facilitate micro-teaching simulations and virtual classroom experiences, offering student-teachers practical exposure in a risk-free environment (Chen et al., 2019; Musa & Omotayo, 2023). Examining the opportunities and problems posed by AI in pre-service biology teacher preparation is crucial given the dual realities of potential and constraint. In order to prepare aspiring biology teachers for the digital era, responsive teacher education policies, curricula, and support systems can be developed with a sophisticated awareness of these dynamics. Preparing pre-service teachers to ethically and effectively utilize AI's potential is still a top concern for sustainable science education reform, as the technology continues to transform educational environments around the world (World Bank, 2023; Nwakpa & Udeh, 2024).

### **Statement of the Problem**

The rapid advancement of Artificial Intelligence (AI) in education presents both promise and complexity for teacher preparation programs, especially in science-related disciplines such as Biology. Pre-service Biology teachers must now not only grasp content knowledge and pedagogy but also develop competencies in emerging technologies like AI. However, many teacher education institutions, particularly in developing contexts, struggle with inadequate digital infrastructure, insufficient training on AI tools, and curriculum gaps that limit the exposure of pre-service teachers to AI applications. Moreover, the absence of a structured framework for integrating AI into Biology teacher education leaves student-teachers underprepared for 21st-century classrooms. While the opportunities offered by AI, such as intelligent tutoring systems, virtual labs, and automated assessments, are substantial, barriers such as technical skill deficiencies, lack of institutional support, ethical concerns, and resistance to technological change hinder effective integration. There



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is a need to systematically explore these challenges and opportunities within pre-service Biology teacher education, identify gaps, and recommend sustainable strategies. Without a clear understanding of how AI is being engaged or resisted in these programs, efforts to modernize science education may remain fragmented or ineffective.

### Objectives of the Study

The specific objectives are to:

1. Examine the current level of awareness and use of AI tools among pre-service Biology teachers in Federal University of Education, Zaria
2. Identify the challenges faced in integrating AI technologies into Biology teacher education programs in Federal University of Education, Zaria.
3. Investigate the potential benefits and opportunities AI offers for improving pre-service Biology teaching and learning among preservice Teachers in Federal University of Education, Zaria
4. Explore institutional and curriculum-related factors influencing AI adoption in Biology teacher education in Federal University of Education, Zaria

### Research Questions

1. What is the current level of awareness and use of AI tools among pre-service Biology teachers in Federal University of Education, Zaria?
2. What are the major challenges faced by pre-service Biology teacher education programs in adopting AI in Federal University of Education, Zaria?
3. What opportunities does AI provide for enhancing the teaching and learning of Biology among pre-service teachers in Federal University of Education, Zaria?
4. How do institutional factors and curriculum content influence the integration of AI into Biology teacher education in Federal University of Education, Zaria?

### Research Hypotheses

- Ho<sub>1</sub>:** There is no significant relationship between the level of AI awareness and the use of AI tools among pre-service Biology teachers in Federal University of Education, Zaria.
- Ho<sub>2</sub>:** Institutional support has no significant influence on the integration of AI in pre-service Biology teacher education program in Federal University of Education, Zaria.
- Ho<sub>3</sub>:** There is no significant difference in AI tool usage between male and female pre-service Biology teachers in Federal University of Education, Zaria.

### Research Methodology

This study employed a descriptive survey research design to explore the challenges and opportunities of Artificial Intelligence (AI) in pre-service Biology teacher education. The study was conducted at the Federal University of Education, Zaria, located in Zaria Local Government Area, Kaduna State. The population comprised all pre-service Biology students in Federal University of Education Zaria, during the 2024/2025 academic session. The sample size of 225 students was determined using the Krejcie and Morgan (1970) sample size determination table. A simple random sampling technique was employed to select the participants. Data were collected using a structured questionnaire titled *Challenges and Opportunities of Artificial Intelligence in Pre-service Biology Teacher Education Questionnaire (COAIPBTEQ)*. The instrument was validated by two experts from the Department of Biology, Federal University of Education, Zaria. Reliability of the instrument was determined using the split-half method, yielding a reliability coefficient of 0.88, indicating high internal consistency. The questionnaire was distributed digitally through students' online platforms (such as WhatsApp groups). The responses obtained were evaluated inferential statistics to test the hypotheses.



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## Presentation of Results

**H<sub>01</sub>:** There is no significant relationship between the level of AI awareness and the use of AI tools among pre-service Biology teachers in Federal University of Education, Zaria.

Variables Compared	N	Correlation (r)	p-value	Strength	Decision
Awareness and Use Scores	225	-0.101	0.131	Weak/None	N.S.

There is no statistically significant relationship between the level of awareness and the use of AI tools among pre-service Biology teachers ( $r = -0.101$ ,  $p > 0.05$ ). This means being aware of AI does not necessarily translate into using it.

**H<sub>02</sub>:** Institutional support has no significant influence on the integration of AI in pre-service Biology teacher education in Federal University of Education, Zaria.

Group	N	Mean	SD	t	Df	p-value	Decision
High Institutional Support	112	3.40	0.60	10.04	223	< 0.001	Significant
Low Institutional Support	113	2.80	0.50				

The result of hypothesis H<sub>02</sub> shows a statistically significant difference between the groups with high and low institutional support regarding the integration of AI in pre-service Biology teacher education. Participants from institutions with high support had a higher mean score ( $M = 3.40$ ,  $SD = 0.60$ ) compared to those with low support ( $M = 2.80$ ,  $SD = 0.50$ ). The t-test yielded a value of  $t(223) = 10.04$  with a p-value less than 0.001, indicating that the difference is statistically significant. Therefore, the null hypothesis (H<sub>02</sub>), which states that institutional support has no significant influence on AI integration, is rejected. This suggests that higher levels of institutional support positively influence the integration of AI in pre-service Biology teacher education.

**H<sub>03</sub>:** There is no significant difference in AI tool usage between male and female pre-service Biology teachers in Federal University of Education, Zaria.

Gender	N	Mean	SD	t	df	p-value	Decision
Male	120	2.70	0.50	3.91	223	0.0001	Significant
Female	105	2.50	0.50				

The result of hypothesis H<sub>03</sub> indicates a significant gender difference in the use of AI tools among pre-service Biology teachers. Male participants had a higher mean score ( $M = 2.70$ ,  $SD = 0.50$ ) compared to their female counterparts ( $M = 2.50$ ,  $SD = 0.50$ ). The independent t-test yielded a value of  $t(223) = 3.91$  with a p-value of 0.0001, which is statistically significant. As a result, the null hypothesis (H<sub>03</sub>), stating that there is no significant difference in AI tool usage between male and female pre-service Biology teachers, is rejected. This finding suggests that male pre-service teachers use AI tools more frequently than female pre-service teachers.

## Discussion of Findings

The finding that there is no statistically significant relationship between pre-service Biology teachers' awareness of AI and their actual use of AI tools ( $r = -0.101$ ,  $p > 0.05$ ) emphasized a disconnect between knowledge and practice in AI integration. This supports the argument by Ede and Ndudi



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(2019), who identified that while Nigerian teacher education programs may discuss AI in theory, they rarely equip students with opportunities for hands-on experience. Olalekan and Salami (2022) echoed this by emphasizing the lack of curriculum components dedicated to AI skill development, resulting in a superficial understanding that rarely translates into practice. Afolabi and Odeyemi (2021) further stressed that resistance to adopting AI stems not from lack of awareness, but from a lack of structured exposure and institutional prioritization. In agreement, Obielodan, Oladejo, and Ayodeji (2023) found that although a significant number of pre-service teachers were aware of tools like ChatGPT and virtual simulations, very few had actually used them in instructional settings. Shu and Guo (2021) emphasized that effective AI implementation requires more than awareness—it demands pedagogical integration strategies and continuous practice. Chen, Xie, and Hwang (2019) reinforced this by presenting a model where AI awareness only led to usage when scaffolded with system-wide institutional support and teacher modeling. Furthermore, Yakubu and Bello (2023) highlighted ethical and cultural concerns, which may make some students hesitant to fully engage with AI despite being aware of its relevance. Overall, the findings reveal that awareness alone is insufficient without structured and experiential learning pathways.

The observed significant difference in AI integration between students with high and low institutional support ( $p < 0.05$ ) confirms the central role institutions play in enabling or hindering AI adoption in teacher education. According to Musa and Omotayo (2023), Nigerian universities with investments in virtual reality, smart classrooms, and instructor training report higher rates of AI use and confidence among their students. Ajayi, Bakare, and Ogunleye (2020) similarly observed that the availability of AI-enabled platforms enhances science learning engagement in institutions with better digital infrastructure. Nwakpa and Udeh (2024) emphasized the importance of institutional policy frameworks that support AI in science education, noting that students thrive better when systems provide both digital tools and guidelines for use. UNESCO (2021) and the World Bank (2023) have also recognized institutional readiness as a foundational element of successful AI integration, especially in developing nations. Alhassan and Nwokedi (2023) reported that many institutions in sub-Saharan Africa still lag in AI readiness due to infrastructural gaps and policy inertia. Afolabi and Odeyemi (2021) also found that institutions with proactive leadership and investment in faculty AI training were more likely to foster meaningful student engagement. This finding aligns with Okonkwo, Etuk, and Ebong (2022), who noted that intelligent tutoring systems and adaptive learning platforms are only effective when institutions provide structured, consistent access and support mechanisms. The study revealed a significant gender difference in AI tool usage, with male students using AI tools more frequently than female students ( $p < 0.05$ ). This confirms longstanding concerns about gender gaps in digital literacy and access. Chukwudi and Kalu (2020) observed that male pre-service Biology teachers in Nigerian colleges were more likely to explore new AI technologies, partly due to societal encouragement toward technical fields. Similarly, Olalekan and Salami (2022) noted that female students often experience lower confidence in handling digital tools due to early exposure disparities and lack of targeted encouragement. Afolabi and Odeyemi (2021) emphasized the importance of creating inclusive digital learning environments that deliberately engage female students in AI training activities. Yakubu and Bello (2023) pointed out that ethical concerns, intimidation in male-dominated tech spaces, and a lack of female role models in educational technology contribute to the gap. Alhassan and Nwokedi (2023) also found that gender disparities in AI use persist across institutions unless addressed through specific interventions. Globally, UNESCO (2021) has called for equity-driven digital education strategies, warning that AI could worsen gender inequalities if access, content, and instruction are not made gender-inclusive. Suryawanshi,



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Bhutada, and Kadam (2023) further emphasized the need for gender-sensitive design in AI learning platforms to accommodate different user experiences. This finding reaffirms the urgent need for intentional, gender-responsive digital inclusion policies in teacher education. The integration of AI into pre-service Biology education holds significant potential to transform teaching and learning processes. Supporters argue that AI can personalize learning experiences, provide intelligent tutoring systems, and facilitate access to rich multimedia resources that enhance conceptual understanding (Luckin et al., 2016; Holmes et al., 2019). For instance, AI-powered simulations can help pre-service teachers visualize complex biological processes, improving their instructional skills before entering real classrooms (Chen et al., 2020). Furthermore, AI can automate assessment and feedback, allowing for more timely and targeted interventions (Woolf, 2010). On the other hand, critics caution that over-reliance on AI tools may diminish essential human elements of teaching, such as empathy and contextual judgment, which are critical in Biology education (Selwyn, 2019). Additionally, infrastructural challenges and limited AI literacy among pre-service teachers may hinder effective implementation (Afolabi & Odeyemi, 2021). There are also concerns about data privacy and the ethical implications of AI in educational settings (Williamson & Piattoeva, 2020). Despite these challenges, the potential benefits of AI in pre-service Biology teaching—ranging from enhanced engagement and individualized support to efficient resource management—warrant thorough investigation to guide effective integration and policy formulation.

## Conclusion

This study examined the challenges and opportunities of Artificial Intelligence (AI) integration in pre-service Biology teacher education, with a focus on awareness, usage, institutional support, and gender disparities. One of the key findings revealed that while many pre-service teachers were aware of AI as a concept, this awareness did not significantly translate into the actual use of AI tools. This indicates a critical disconnect between theoretical exposure and practical application, highlighting the need for experiential and skill-based AI training. The gap suggests that awareness campaigns alone are insufficient without hands-on opportunities that foster confidence and competence. Furthermore, the study found that institutional support plays a significant role in AI adoption. Students from institutions with strong infrastructure, policies, and faculty support were more likely to engage with AI in meaningful ways. In contrast, poor access to AI resources and lack of structured training in less-equipped institutions posed significant barriers. Additionally, a notable gender gap in AI usage was observed, with male students engaging more frequently with AI tools than female students. This finding underscores the urgent need for gender-responsive digital literacy programs to ensure equitable participation in AI-enhanced teacher education.

## Recommendations

1. Curriculum planners should embed practical AI applications, simulations, and tool-based workshops into Biology teacher education programs.
2. Government and educational institutions like FUE Zaria should invest in digital infrastructure such as internet connectivity, smart classrooms, and AI-enabled platforms.
3. To close the gender gap in AI usage, targeted interventions such as mentorship for female students, inclusive digital skills workshops, and equitable access to AI tools should be prioritized.

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