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EXPLORING SCIENCE TEACHERS' ATTITUDES AND COMPETENCY IN USING AI FOR SUSTAINABLE CHEMISTRY AND PHYSICS EDUCATION AMONG COLLEGES OF EDUCATION IN OGUN STATE, NIGERIA

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Abstract

The integration of Artificial Intelligence (AI) in education is transforming teaching and learning methodologies globally. However, its adoption in Nigerian science education, particularly in chemistry and physics, remains underexplored. This study examines the attitudes and competency levels of science teachers in colleges of education toward AI integration for sustainable chemistry and physics education. Employing a descriptive survey research design, data were collected from 66 lecturers (34 chemistry and 32 physics), through, a stratified random sampling, in Ogun State using a structured questionnaire. The instrument's validity was ensured through expert review and pilot testing, while reliability was confirmed using Cronbach's Alpha (0.82–0.85), indicating high internal consistency The findings reveal that while 60.61% of lecturers hold positive attitudes toward AI, 34.85% report low competency in AI integration. Key challenges include limited AI training (54.55%) and restricted access to AI tools (45.45%). The study underscores the need for targeted professional development programs, improved infrastructure, and policy support to enhance AI adoption in science education. By addressing these barriers, AI can be leveraged to foster sustainable education and equip future educators with essential digital competencies.

Keywords: Artificial Intelligence, Science Education, Teachers' Attitudes, AI Competency, Sustainable Development

Introduction

The rapid advancement of artificial intelligence (AI) has redefined the educational landscape across the globe, creating unprecedented opportunities to enhance teaching and learning processes. AI is no longer a futuristic concept it is a present reality shaping education, industry, and research. AI-powered tools have the potential to personalize learning, facilitate inquiry-based instruction, and provide data-driven insights to improve student engagement and academic achievement (Chen, et al. 2022). However, as with all these groundbreaking prospects, the effective integration of AI in science classrooms largely depends on teachers' attitudes and competencies in leveraging these technologies (Chounta, Bardone & Pedaaste, 2022).

Teachers are the bridge between knowledge and innovation without their willingness and ability to adapt, even the most powerful tools remain ineffective (United Nations Educational, Scientific and Cultural Organization, 2019). The question arises: Are science teachers in colleges of education equipped, motivated, and willing to embrace AI as a tool for sustainable chemistry and physics education? Science teachers in colleges of education serve as catalysts for molding future educators who will, in turn, shape the next generation of scientists and innovators. Their

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perceptions and proficiency in using AI-based tools can determine the extent to which these technologies are embraced in the teaching and learning of chemistry and physics. In Nigeria, a country known for its rich academic tradition. The readiness of science teachers to integrate AI for sustainable development remains an area that requires empirical exploration. Understanding their attitudes and competency levels is essential for crafting effective professional development programs and policies that will drive AI adoption in science education. This study aligns with the principles of Education for Sustainable Development (ESD) by UNESCO, which promotes the use of innovative educational strategies to prepare students for the challenges of the future (UNESCO, 2022).

Guided by Albert Bandura's (1986) Social Cognitive Theory (SCT) and Lent, Brown, and Hackett's (1994) Social Cognitive Career Theory (SCCT), this research recognizes that human agency, self-efficacy, and environmental influences shape teachers' adoption of AI. The interplay between personal motivation, institutional support, and perceived career impact will determine whether educators embrace AI as a tool for sustainability or view it as an unnecessary disruption. "Knowledge alone is insufficient—application is key" the technological pedagogical content knowledge (TPACK) framework by Mishra and Koehler (2006) emphasizes that effective AI integration requires a balance between subject expertise, pedagogy, and digital literacy.

Literature review

AI and Sustainable Development in Chemistry and Physics Education

Artificial Intelligence (AI) encompasses computational technologies that enable machines to simulate human intelligence and make informed decisions (Dong, Zhang, & Zhang, 2020**).** Is said to be a computer system that can carry out activities connected with human intelligence, i.e. AI possesses the ability to think, interpret language, and comprehend its surroundings while solving problems (Nilsson, 2009). In education, AI facilitates personalized learning, streamlines administrative processes, and offers learning analytics to enhance students' knowledge acquisition, skill development, and teacher effectiveness. Zudunu et al. (2024) found AI-based instruction improved student achievement and conceptual change and with significant advantage over traditional teaching. Also Park et al. (2023) found that science teachers saw AI and science as complementary for sustainability but faced challenges in content mastery and curriculum adaptation. The integration of AI in chemistry and physics education offers several opportunities for promoting sustainable development (Zudonu, 2024).

Sustainable development is defined as fulfilling present needs without jeopardizing the ability of future generations to meet their own (Brundtland Commission, 1987). As fundamental scientific disciplines, chemistry and physics play a vital role in addressing environmental challenges. Incorporating sustainability into the teaching of these subjects is crucial for nurturing future scientists and educators who are mindful of their environmental impact. AI-powered tools can enhance students' comprehension of sustainable practices by offering real-time data analysis, simulations, and interactive learning experiences.

For instance, AI can simulate chemical reactions and assess their environmental effects, enabling students to explore green chemistry principles and develop eco-friendly solutions (Chen, Cao, &

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Zheng, 2020). Studies by Chen et al. (2022) and Singh et al. (2024) highlighted AI's role in promoting green chemistry by enabling predictive modeling, reducing chemical waste, and enhancing safety in laboratory practices. AI-driven simulations were found to enhance students' understanding of complex physics concepts while minimizing environmental impact. Likewise, AI-driven simulations in physics can help students grasp concepts related to renewable energy, climate change modeling, and other sustainability-focused topics (Adera, 2025). Moreover, AI can facilitate the development of digital laboratories that provide remote access to experimental setups, reducing the need for physical resources and minimizing waste. These virtual labs can offer hands-on learning experiences that are essential for understanding scientific principles while promoting sustainability ((Mahmoud, 2020). By integrating AI into chemistry and physics education, teachers can create learning environments that emphasize the importance of sustainability and equip students with the skills and knowledge needed to address environmental challenges. However, the extent to which these benefits are realized depends on two critical factors; teachers' attitudes toward AI in education and teachers' competency in AI integration.

Teachers' Attitudes toward AI in Science Education

Attitude is the bedrock of transformation. According to the Technology Acceptance Model (TAM) by Davis (1989), perceived usefulness and ease of use are key determinants of technology adoption. Teachers' perceptions of AI whether as an enabler or a disruptor will significantly influence their willingness to integrate it into their pedagogy. Positive attitudes breed innovation, while resistance leads to stagnation. Several studies have examined the perceptions of science teachers toward AI in education. A study by Akgun and Greenhow (2023) found that while teachers acknowledged AI's potential in science education, concerns about ethical implications and loss of pedagogical control influenced their attitudes. Similarly, Al-Sharafi et al. (2021) reported that teachers in higher education institutions expressed mixed attitudes toward AI, with some viewing it as an enabler of student-centered learning while others feared dependency on technology. In the Nigerian context, Ojo, (2024) investigated secondary school science teachers' attitudes toward AI, finding that teachers with prior exposure to AI tools showed more positive attitudes than those with limited experience. However, resistance to AI adoption was noted, particularly among teachers with inadequate professional development. Darayseh (2023) used the Technology Acceptance Model (TAM) to examine factors influencing science teachers' use of AI in Abu Dhabi. A survey of 83 teachers found high AI acceptance, with positive links to self-efficacy, ease of use, benefits, attitudes, and behavioral intentions. Anxiety and stress had no significant impact. The study predicts that benefits, ease of use, and attitudes explain 71.4% of AI adoption behavior. Study by Stryftoy et al. (2024) showed that an AI Learning intervention improved primary teachers' attitudes and self-efficacy in teaching physics. Another study by Lam, Chan, and Wong (2023) found that higher education teachers saw AI as both beneficial and concerning. They felt confident in teaching AI and staying updated but needed administrative support for implementation.

Competency of Science Teachers in Using AI for Chemistry and Physics Education

Competency in AI-assisted teaching requires knowledge of AI applications and the ability to integrate them effectively into instructional design (Isaacs, 2024). Competency is not merely about

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knowledge it is the ability to apply knowledge effectively. Professional development programs that focus on building teachers' AI competency can play a vital role in ensuring the successful integration of AI in education (Darling-Hammond, Hyler, & Gardner, 2017). In a study conducted by Ayanwale, Adelana, and Odufuwa, (2024) chemistry and physics teachers demonstrated varying levels of competency in using AI for personalized learning and laboratory simulations, with experienced teachers showing better adaptability. A recent study in Sub-Saharan Africa by Okon et al. (2023) indicated that while AI literacy among science teachers was increasing, a significant gap remained in practical AI application due to limited training opportunities. Their findings emphasized the need for capacity-building programs tailored to science educators. In Nigeria, a study by Yusuf and Akinwale (2023) assessed lecturers' AI competency in colleges of education and found that only 35% of science lecturers had received formal training on AI applications in teaching. The study recommended continuous professional development programs to bridge the skill gap, as AI has been explored as a tool for fostering sustainability in science education.

Statement of the problem

Despite the promising benefits of AI in science education, several challenges hinder its implementation. Studies have highlighted issues such as limited AI literacy among teachers (Yusuf & Akinwale, 2023), inadequate technological infrastructure (Okon et al., 2023), and concerns about ethical implications and job security (Çelik, 2023). Teachers' perceptions of AI as either an enabler or a disruptor significantly influence their willingness to integrate it into their pedagogy (Davis, 1989). Furthermore, the competency of teachers in using AI is not just about technical knowledge but also the ability to apply it effectively in classroom instruction (Darling-Hammond, Hyler, & Gardner, 2017). Teachers' insufficient knowledge of AI leads to low performance in implementing AI in their classrooms (Park et al., 2023).

In Nigeria, where education plays a critical role in shaping future educators, there is a lack of empirical data on science teachers' attitudes and competencies regarding AI adoption. Without this understanding, efforts to develop professional training programs and policies for AI integration in chemistry and physics education may be ineffective. This study seeks to fill this gap by exploring the perceptions, competencies, and challenges faced by science teachers in Ogun State colleges of education in adopting AI for sustainable chemistry and physics education. The findings will inform strategies to enhance AI adoption, ultimately contributing to Education for Sustainable Development (ESD) as advocated by UNESCO.

Research Objectives:

1. To assess the attitudes of science teachers toward using AI for sustainable chemistry and physics education.
2. To evaluate the competency levels of science teachers in integrating AI-enhanced educational practices.
3. To identify the challenges and barriers faced by science teachers in adopting AI technologies.

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1.4 Research Questions:

1. What are the attitudes of science teachers toward the use of AI in teaching sustainable chemistry and physics?
2. What is the competency level of science teachers in integrating AI-enhanced educational practices?
3. What challenges and barriers do science teachers face in adopting AI technologies for sustainable Science education

Research Methodology

This study employed a descriptive survey research design to assess the attitudes and competencies of science lecturers in Ogun State colleges of education regarding AI integration in chemistry and physics teaching. The population comprised all chemistry and physics lecturers from four colleges of education in Ogun state (these includes two private college, one federal college and one state college). A sample size of 66 (34 chemistry lecturers and 32 physics lecturers), was selected through stratified random sampling. This sample size was determined based on Krejcie and Morgan table. A structured questionnaire named, Teachers Attitudes and Competency in AI Integration Questionnaire contained 20 items was used for data collection, covering demographics, attitudes, competencies, and challenges. The validity of the instrument was ensured through expert review and pilot testing, while reliability was confirmed using Cronbach's Alpha (0.82–0.85), indicating high internal consistency. Data collection involved self-administered questionnaires, analyzed using SPSS for descriptive (mean, standard deviation). Ethical approval was obtained, ensuring confidentiality, voluntary participation, and informed consent. This methodology ensures a reliable framework for evaluating AI adoption in science education.

Analysis of Data on Science Teachers' Attitudes and Competency in Using AI for Teaching Chemistry and Physics

1. Demographic Information The sample consisted of 66 lecturers, comprising 34 chemistry lecturers (51.5%) and 32 physics lecturers (48.5%). This distribution ensures a balanced representation of subject expertise among the respondents. The data collected allows for a comprehensive understanding of how AI integration is perceived across both disciplines.

2. Attitudes Toward AI and Digital Tools in Teaching.

The analysis of science teachers' attitudes toward AI integration is presented in Table 1.

Attitudes of Science Teachers Toward AI in Education (N = 66)

Attitude Category	Frequency (n)	Percentage (%)
Strongly Positive	15	22.73

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Positive	25	37.88
Neutral	10	15.15
Negative	8	12.12
Strongly Negative	8	12.12

Table 1

Findings indicate that 60.61% of the lecturers have a positive attitude towards AI in teaching, while 24.24% exhibit negative attitudes. This suggests that most science educators recognize AI's potential but some skepticism remains. The neutral responses (15.15%) indicate a need for further sensitization and capacity-building efforts to ensure more educators feel confident about AI adoption in their classrooms.

3. Competency in Integrating AI in Teaching. Table 2 presents the competency levels of science teachers in using AI for teaching chemistry and physics.

Competency Levels of Science Teachers in AI Integration (N = 66)

Competency Level	Frequency (n)	Percentage (%)
Very High	8	12.12
High	20	30.30
Moderate	15	22.73
Low	18	27.27
Very Low	5	7.58

Table 2

Findings reveal that 42.42% of lecturers report high to very high competency, whereas 34.85% indicate low to very low competency. This highlights a competency gap that could be addressed through targeted training. A significant portion of respondents (22.73%) reported moderate competency, suggesting that with proper training and exposure, more lecturers could develop proficiency in AI applications.

4. Challenges and Barriers to AI Integration

Table 3 outlines the challenges faced by lecturers in integrating AI.s.

Challenges Faced by Science Teachers in AI Integration (N = 66)

Challenge Category	Frequency (n)	Percentage (%)

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Lack of Training	36	54.55
Limited Access to AI Tools	30	45.45
Technical Difficulties	25	37.88
Resistance to Change	15	22.73
Time Constraints	18	27.27

Table 3

The most significant barrier is the lack of training (54.55%), followed by limited access to AI tools (45.45%). These findings suggest that professional development programs and increased accessibility to AI resources could enhance AI adoption in science education. Technical difficulties (37.88%) indicate that infrastructure and technical support need improvement. Resistance to change (22.73%) reflects concerns among some educators about AI's impact on traditional teaching methods, necessitating efforts to demystify AI's role in education.

Discussion of Findings

The findings align with previous studies, such as Akgun and Greenhow (2023), which reported that teachers acknowledge AI's potential but face barriers to integration. The study also supports Okon et al. (2023), who found that inadequate training and infrastructure hinder AI adoption in Sub-Saharan Africa. Additionally, the findings reinforce the Technology Acceptance Model (Davis, 1989), emphasizing that perceived usefulness and ease of use significantly impact technology adoption.

The competency levels reported in this study are consistent with Yusuf and Akinwale (2023), who found that only 35% of lecturers in Nigerian colleges of education had formal AI training. This supports the recommendation that structured training programs be introduced to bridge the competency gap. Moreover, the resistance to AI integration observed in this study aligns with Park et al. (2023), who highlighted that teachers' uncertainty about AI's role in science education contributes to slow adoption rates.

Overall, the study confirms that while there is a willingness to adopt AI, challenges related to training, resources, and technical difficulties must be addressed through targeted policies and investments.

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Conclusion

The study highlights that most science lecturers in colleges of education have a positive attitude toward AI, but challenges such as lack of training and limited resources hinder its adoption. Despite this, a significant proportion of lecturers demonstrate moderate to high competency in using AI. Addressing these barriers could facilitate greater AI adoption, leading to improved teaching methodologies and enhanced student learning experiences in sustainable chemistry and physics education.

Recommendations

1. Professional Development Programs: Institutions should implement structured training programs to improve AI competency among lecturers. Regular workshops, certifications, and mentorship programs should be introduced.

2. Access to AI Tools and Resources: Colleges of education should invest in AI infrastructure and make digital tools more accessible to educators to encourage practical implementation.

3. Institutional and Policy Support: Policymakers should develop clear frameworks and incentives for AI adoption in sustainable STEM education. Government and educational bodies should facilitate funding and technical assistance.

4. Further Research: More studies should explore the effectiveness of specific AI tools in science education to identify best practices and optimize AI's impact on learning outcomes.

These findings provide a foundation for future initiatives aimed at fostering AI-driven sustainable education in chemistry and physics. By addressing identified barriers and leveraging opportunities, institutions can ensure that AI becomes an integral part of modern science education.

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