



LECTURERS' AWARENESS AND ATTITUDE TOWARDS ARTIFICIAL INTELLIGENCE FOR TEACHING BIOLOGY IN UNIVERSITIES IN SOUTHEASTERN NIGERIA

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Abstract

The study investigated lecturers' awareness and attitude towards application of artificial intelligence for teaching biology in universities in Southeastern Nigeria. The study adopted descriptive survey research design. Four research questions guided the study. The population comprised 267 lecturers in Biology unit of Department of Science Education from 12 Universities in Southeastern Nigeria. Two instruments developed by the researchers titled "Lecturers' Artificial Intelligence Awareness Scale" (LAIAS) and "Lecturers' Attitude towards application of Artificial Intelligence for Teaching Biology Questionnaire" (LAAITBQ) were used for data collection. The instruments were validated by two experts in Department of Science Education, and one expert in Department of Education Foundations, Faculty of Education, University of Nigeria, Nsukka. The reliability coefficient of the instruments was 0.80 and 0.85 respectively using Kuder Richardson 20 and Cronbach Alpha. Mean and standard deviation were used to answer research questions. The findings of the study revealed that there were negative awareness and attitude of lecturers towards application of AI for teaching Biology. It was recommended among others that the government should organize workshops to sensitize lecturers to adopt positive awareness and attitude towards artificial intelligence in teaching Biology.

Keywords: Artificial intelligence, biology teaching, teachers' awareness, and attitude

Introduction

The integration of artificial intelligence (AI) into biology teaching and learning has been a significant focus of educational development all over the world. AI is rapidly growing and almost altering our ways of thinking, behaving, and interacting with one another (Okan & Antoli, 2023). Presently students make use of various kinds of technology especially artificial intelligent gadgets to meet up with the current issues in biology (Eneve et al., 2024). Biology is a vital science subject that has enabled students to acquire knowledge on the improvement of production of drugs, food species and others (Awodufu et al., 2020). The curriculum of biology in universities is designed to broaden the students' knowledge for useful living and further studies in the society. With the recent advances in the field of ecology, genetics, conservation, and others, the scope of Biology has widened. It requires appropriate instructional methods to understand nature, the environment, and the application of biological concepts. This means that the current learning experience in Biology should encourage students to observe and explore the scientific environment to have a positive achievement.



However, there has been dwindling achievement of students in Biology in universities in Southeastern Nigeria. Adebajo (2019) reported that teaching of Biology using inappropriate instructional methods such as lecture has consistently resulted in poor achievement. In this situation students often find it difficult to understand certain Biology topics and try to learn by memorization without applying their reasoning or intelligence. Intelligence is the ability to receive information, elaborate on it and produce effective answers. According to Samuel et al. (2020) intelligence must involve ability to adjust, ability to learn and ability to carry out abstract thinking and may vary from very low to very high level. It is obvious that the role of the lecturer is to help students attain maximum achievement in learning using their intelligence. Since poor achievement results from using only natural intelligence, there is need to provide students with personalized learning to have good understanding of Biology, hence the need for artificial intelligence.

AI has been recognized in several disciplines with different views and this makes it to have various definitions. Copeland (2022) posited that AI is the ability of computer to carry out tasks related to intelligent entities. Garcia-Martinez et al. (2023) made further clarifications by stating that AI is any machine that carries out human work to mechanize the tasks they perform every day with the purpose of accomplishing more in less time. AI is a set of technologies that enable computers to perform a variety of advanced functions including the ability to see, understand and translate spoken and written languages and make recommendations. Though there are human qualities that cannot be reproduced by AI such as creativity or ability to produce new ideas or to improvise and constantly come up with a change. AI is still considered as important in universities because the application of computer assisted systems act in similar forms like human intelligence to ensure excellence in Biology instruction.

AI is associated with many applications to develop training modules, courses, and extracurricular activities. AI can support the curriculum, assessment strategies, pedagogy, school and class organization, administration, and professional development (Lee et al., 2024). The AI applications in universities selected in the web of science (WoS) are artificial intelligence or machine intelligence or intelligent support or intelligent virtual reality or chatbot, or automated tutor or collaborative robots and others (Zawacki- Richter et al., 2019). Some universities widely use AI technologies in Biology such as google meet, zoom and WhatsApp applications in developing innovative teaching and learning practices. The google meet session offers students opportunity to discuss, play and interact online with classmates and lecturers (Davy & Samuel, 2021). When AI is used with the proper pedagogical strategies to assist students in understanding biological concepts, there is greater access of information.

AI tools can also assist Biology lecturers in better understanding their students and improve the efficiency of classroom related instructions. AI tools enable lecturers to produce expected outcomes such as the use of grading software and task automation software. This could help in prediction of students' performance (examples are high dropout rates, low homework completion rates and poor learning outcomes). Early detection of these problems and adoption of preventive measures could improve their achievement (Luan & Tsai, 2021). Some AI based designs, websites and applications are multidimensional with Biology inclusive. These provide instruction and feedback to students by identifying individual students' needs, for instance, AI tools can help students with hearing or visual impairments, physical disabilities as well as those who don't speak the language very well (Serkin et al., 2016). Tools like audio transcribers included in Microsoft



teams can help students with hearing impairments to understand lectures while speech to text technologies can also help in taking class notes or performing written examination.

These tools bring new meaning to onsite and online education ensuring that every student has equal opportunity to perform academically. AI supports Biology lecturers by encouraging them to understand students learning process, provide anywhere and anytime prompt discussions and feedback, improving the evaluation process and administrative activities of the universities (Gonzalez-Calatayud et al., 2021). For instance, previously grading assignments for a single class which requires Biology lecturers to use several hours to carefully go through each submission now have slashed the grading time to 50% using AI (Zhang & Aslan, 2021). Chu et al., (2022) posited that lecturers need to have the knowledge of the latest development in the research and practice of AI in universities.

Biology lecturers can use AI in lesson delivery to enhance students learning experiences and make the lesson more engaging and interactive in several ways such as using AI-driven simulations to demonstrate biological process, photosynthesis, or genetics. Simulations can allow students to experiment and individualize their potentials using virtual laboratory environment (Cabero-Almenara, & Costas, 2016). In ecology, it can use virtual fieldtrip in species identification, biodiversity monitoring and observing wildlife behavior. This is used to offer more real learning situations by allowing students to interact with an outside environment within the classroom. Other ways could be by using questions and answers, watching instructional videos and even intelligent tutoring. Barbalios et al. (2013) used a realistic virtual environment with 3D technology where water simulations are developed to help students to acquire complex abstract knowledge in ecosystem. This makes the students acquire the knowledge and skills that could promote learning based on the current situation in Biology. With this fact, lecturers help students to learn through customized study material in a friendly environment and abstract topics are made meaningful for students.

AI plays an important role in improving students' lives by engaging them to learn, experiment and explore to increase the quality of life and make more informed decisions. Students require a long time to develop a full understanding of AI concepts and enjoy the lesson. This is possible if proper implementation of the curriculum is provided for students to be empowered to understand, use, and evaluate AI. According to Ugwuoti et al. (2023) while students found AI tools helpful in understanding complex Biology concepts, there was variability in their perceptions and preference for lecture method. Improving the students understanding of complex Biology concepts requires preparing students to be active and efficient in future while engaging in AI activities (Sanusi et al., 2023). Unfortunately, one of the problems encountered in preparing students for future is the limited knowledge of students and that of the lecturers in AI. There are many factors responsible for the limited knowledge of the lecturers in AI, these include lecturers' readiness, perception, competence, awareness, and attitude towards AI instructions. To improve their teaching, it is necessary to consider the awareness and attitude of lecturers who will implement the change (Ferikoglu & Argun, 2022).

AI awareness is a process of having initiative that AI exists or understanding what is going on. Some lecturers perceive AI awareness positively while others view it negatively. There should be awareness of lecturers in AI so that students can take better advantage of its benefits. The



diversion of lecturers' interest and time to assimilate the AI information cast some doubt about the level of awareness towards AI in Biology. Presently, there have been efforts and investigations on using AI in African schools. Studies have shown that most of the AI applications used in Africa come from other continents and as such do not consider our cultural background and available infrastructure. Oyelere et al. (2022), in their study on how AI was taught in grades k12 in African schools, noted that AI awareness was lacking and that teachers found it difficult to teach the students using AI. If lecturers are aware of AI to enhance students' achievement, they are more likely to have a positive attitude toward it.

Attitude is the level of a lecturer's favourable or unfavourable behaviour towards something. This is the tendency to engage or avoid the activities (Ayanwale et al., 2022). There could be positive, neutral, or negative attitude. Positive attitude of lecturers could make students use AI efficiently and become more future ready. It also enables the lecturers to be knowledgeable and possess the skills of AI. This allows students to acquire problem solving and critical thinking skills and enhance individualization of instruction. Simut et al. (2024) examined relationship between attitude and competence and revealed that there is a significant relationship between attitude and competence development of the lecturer. It is hoped that if lecturers understand the complex concepts using AI, there could be improvement of their attitude towards the subject.

However, there is need to eliminate negative awareness and attitude of lecturers towards AI. Some of the negative awareness and attitude of lecturers that need to be eliminated are inability of lecturers to accept and assimilate appropriate methods for effective classroom instruction (Tondeur et al., 2020). The fact that it replaces human decision with its ideas and that it makes lecturers redundant (Celik et al., 2022). By this view, lecturers who teach Biology using AI have positive awareness and attitude while those who have negative awareness and attitude tend to perform less in Biology teaching using AI.

There are challenges faced in promoting lecturers' awareness and attitude towards application of AI in Biology. These include lack of knowledge, and the terminology is abstract so that it is difficult to understand. Some challenges such as institutional support (administrative encouragement, professional development opportunities and technical infrastructural), availability of training programs, and access to technological resources are faced in creating awareness and attitude of lecturers in AI application in teaching Biology. Other challenges are that there is lack of interest, and the teaching is not enjoyable, the AI algorithms are not adapted to their practical needs and the AI systems are not used in ethical trustworthy, and inclusive way (European commission, 2022). It can generate inequality and segregation of students' performance by favoring students who attend well-rated universities while students from underrepresented groups may be affected (Akgun & Greenhow, 2022). Lastly, lack of collaborative networking for lecturers to share experience could hinder lecturers from developing awareness and attitude towards AI in teaching Biology. It is necessary for lecturers to understand the challenges faced in the AI application in teaching Biology so that they can use authentic measures to bring out their potentials.

To overcome the challenges, lecturers should engage in various certificate programs especially post graduate education after completing their undergraduate education. Inculcation of both theoretical and practical learning on digitalization should start as early as undergraduate level and continue throughout the professional stages to enable the lecturers to be competent in AI



application in Biology (Ayanwale, et al., 2022). The number of content and training opportunities for lecturers should be increased. Since lecturers have vital role to play in impacting the AI knowledge and skills to students, appropriate measures are required to promote their awareness and attitude towards applying AI in teaching Biology. Therefore, there is need to investigate on the lecturers' awareness and attitude towards AI in teaching Biology in universities in Southeastern Nigeria.

The emergence of AI has brought unexpected changes and opportunities in Biology instruction. As the application of AI technology improves the teaching and learning, there is need for lecturers to have positive awareness and attitude towards AI in teaching Biology. Unfortunately, this objective has hardly been achieved despite innovative methods of teaching Biology. This implies that the lecturers should employ AI technology as an appropriate technological tool to impact knowledge to the students since it is relatively new to our educational system. AI has equally been considered as an important tool for making students move from passive to active learning and accessing their own learning. It is against this background that this study investigated lecturers' awareness and attitude towards application of AI in teaching Biology in universities. The aim of this study was to determine lecturers' awareness and attitude towards the applications of artificial intelligence tools in teaching Biology in universities in Southeastern Nigeria. Specifically, the study answered the following questions;

1. What is the lecturers' awareness on the application of artificial intelligence tools in teaching Biology?
2. What is the lecturers' attitude towards the applications of artificial intelligence tools in teaching Biology?
3. What are the challenges responsible for negative awareness and attitude towards application of AI in Biology?
4. What are the measures to increase awareness and attitude towards application of AI in Biology?

Methodology

The study adopted descriptive survey research design. The study was carried out in universities in Southeastern Nigeria during 2022/2023 academic session. The population of the study was 267 lecturers in Biology unit, Department of Science Education from 12 universities in Southeastern Nigeria. Two instruments used for data collection were "Lecturers' Artificial Intelligence Awareness Scale" (LAIAS) and "Lecturers' Attitude towards application of Artificial Intelligence for Biology Teaching Questionnaire" (LAAIBTQ). The instruments had two sections A and B. A was used to get demographic information from the respondents while section B contained 3 clusters, one designed to find out the awareness of teachers, one designed for the challenges and another outlining measures for promoting AI in teaching Biology. LAIAS has 31 items with a 2-point rating scale with weight values Aware (A) and Unaware (UN). LAAIBTQ is 8 items questionnaire with 4-point rating scale with the mode of responses as Strongly Agree (SA), 4, Agree (A), 3, Disagree (D), 2, Strongly Disagree (SD), 1. The instruments were validated by three experts, one from Biology unit, and one from Measurement and Evaluation unit both from Department of Science Education, and also one from computer education unit, Department of Education Foundation, Faculty of Education, University of Nigeria, Nsukka. The reliability coefficient of LAIAS and LAAIBTQ were obtained as 0.80 and 0.85 respectively using Cronbach Alpha. Mean and standard deviation were used to answer research questions.



Results

Table 1 indicates that the frequency of teacher' awareness on the applications of AI in teaching Biology ranged from 15 (5.62%) to 91 (34.68%). The lecturers' percentage ratings of their awareness on the application of all the outlined AI tools were below 50.00% cut off point implying that the lecturers were not aware of the application of these tools in teaching Biology.

Table 1: Frequency and Percentage Rating on Lecturers' Awareness on the Application of Artificial Intelligence Tools in Teaching Biology

S/N	ITEMS	FA	%A	FNA	%NA	Remark
Cluster A	Chatbots AI Tools					
1.	Microsoft Copilot is a Chatbot AI tool that help users browse the internet	31	11.61	236	88.39	NA
2.	ChatGPT is a Chatbot AI tool that interacts with the users the way human would.	72	26.97	195	73.03	NA
3.	Claude is a Chatbot AI tool that enable the user to simplify complex tasks.	29	10.86	238	89.14	NA
4.	Perplexity is a generative AI Chatbot that let the users ask questions and get responses conversationally.	19	7.12	248	92.88	NA
5.	Cswdgel Gemini is an experimental conversation AI that exchanges text-based conversation with users.	35	13.11	232	86.89	NA
6.	PI is a personal companion AI designed to provide answers to questions.	27	10.11	240	89.89	NA
Cluster B	Virtual Designing Tools					
9.	Adobe Express is AI tool designed to give users new way to present their ideas.	20	7.49	247	92.51	NA
10.	Ideogram is an AI image generator.	45	16.85	222	83.15	NA
11.	Microsoft Designer uses AI to quickly create professional quality design.	17	6.37	250	93.63	NA
12.	AutoDraw is a free web-based drawing tool that uses AI to enable users create professional looking drawings.	39	14.61	228	85.39	NA
13.	Pictory is AI tool that make the creation of video easy.	49	18.35	218	81.65	NA
14.	Canva Magic Classroom is AI tool for creating virtual contents.	53	19.85	214	80.15	NA
Cluster C	Lesson Design and Content Creation AI tools					
15.	Curipod is an AI tool that generate slide deck for users.	16	5.99	251	94.01	NA
16.	Diffit is an AI tool that enables users to easily adapt resources for any topic.	48	17.98	219	82.02	NA
17.	Magic School.ai is an AI tool that automates teaching and instructional tasks.	67	25.09	200	74.91	NA
18.	School AI is all-in-one AI platform for classroom instructions.	33	12.36	234	87.64	NA
19.	Brisk teaching is an AI tool that helps teacher to save time and improve teaching.	67	25.09	200	74.91	NA
20.	Antimatter Sorcerer is an AI tool that adds fun, meme and text messaging with Sorcerer.	29	10.86	238	89.14	NA
21.	Teach Aid automates lesson preparation as user's teaching assistants	45	16.85	222	83.15	NA



22.	Education Capilot provides users a template for lesson plans, writing prompts, educational handout, students' reports, etc.	37	13.86	230	86.14	NA
23.	Nolej is an AI tool that generate a lot of interactive educational content	40	14.98	227	85.02	NA
24.	Educaide.ai is an AI tool designed to help teacher with lesson planning and generation of educational contents.	19	7.12	248	92.88	NA
25.	Khanmigo is a virtual tutor and debate partner.	21	7.87	246	92.13	NA
26.	Copy.ai uses machine learning to generate contents such as social media content, emails, web, etc.	26	9.74	241	90.26	NA
Cluster D Teaching Aids						
27.	gotFeedback by gotLearning is an AI tool for individualization of instruction.	38	14.23	229	85.77	NA
28.	Grammarly is an online writing assistant.	43	16.10	224	83.90	NA
29.	Quillbot is an AI powered writing assistants for paraphrasing, summarizing, and improvising text.	77	28.84	190	71.16	NA
30.	Goblin.tools is a free AI app that helps break down tasks into smaller to-do lists.	91	34.08	176	65.92	NA
31.	Hello History provides a library of over 400 chatbots aligned to historical figures which students can use to improve their knowledge	29	10.86	238	89.14	NA
32.	ChatPDF analyzes the PDF and the AI will use relevant paragraphs to give you an answer.	37	13.86	230	86.14	NA
33.	Summarize.tech allows the user to get a summary of any long YouTube video, like a lecture, live event or a government meeting.	15	5.62	252	94.38	NA

Key: NA=Not Aware, A= Aware, FA=Frequency of teachers that were aware, FNA=Frequency of teachers that were not aware

Table 2 shows that the mean ratings on lecturers' attitude towards artificial intelligence in teaching Biology ranged from 2.33 to 3.78 with standard deviation that ranged from 0.43 to 0.83. The Table 2 further revealed that negative worded items, item 1 and item 3 had mean ratings of 2.29 and 2.33 below the 2.50 benchmark. The remaining positive items had mean ratings above 2.50 except for item 5. This implies that the lecturers have positive attitude towards the application of AI in teaching Biology. The small value of the standard deviation indicates that the lecturers were homogenous in their responses.

Table 2: Mean and Standard Deviation Ratings on Lecturers' Attitude towards Artificial Intelligence in Teaching Biology

S/N	Item Statements	Mean	SD	Remarks
1.	I feel less concerned about AI	2.29	0.65	Disagree
2.	I pay keen attention to discussion on AI	3.42	0.72	Agree
3.	I feel uncomfortable when the issues of applying AI in classroom are discussed	2.33	0.43	Disagree
4.	I update my knowledge on application of AI tools in classrooms	2.76	0.76	Agree
5.	I spend my time learning about AI knowledge	2.34	0.83	Disagree
6.	I desire to use AI applications in improving my teaching	2.89	0.46	Agree
7.	I like to teach using AI tools.	3.78	0.37	Agree
8.	I wish the use of AI in classroom should be made compulsory.	2.64	0.61	Agree
	Grand Mean	2.81	0.60	Agree



Table 3 reveals that mean and standard deviation ratings of lecturers on the challenges affecting the application of AI in teaching Biology ranged from 2.68 to 3.78 with standard deviation values that ranged from 0.41 to 0.82. The lecturers rated all the items above the 2.50 benchmark. The small standard deviation values suggest that the lecturers were homogenous in their ratings. The grand mean of 3.23 implies that lecturers agreed that the items constituted the challenges affecting the application of AI in teaching Biology.

Table 3: Mean and Standard Deviations Ratings of Lecturers on Challenges affecting the application of AI in teaching Biology.

S/N	Items	Mean	SD	Remark
1.	Lecturers' inadequate knowledge on AI	3.31	0.46	Agree
2.	Limited access to AI facilities	3.56	0.50	Agree
3.	Inability to integrate AI into subjects' curriculum.	3.70	0.41	Agree
4.	Inability of teachers to receive training on AI applications	3.33	0.76	Agree
5.	Lecturers' poor motivation to use AI	2.78	0.47	Agree
6.	Lecturers' unwillingness to adopt AI-driven teaching strategies	2.68	0.82	Agree
	Grand Mean	3.23	0.57	Agree

Table 4 reveals that mean and standard deviation ratings of lecturers on the measures to increase teachers' application of AI in teaching Biology ranged from 3.08 to 3.83 with standard deviation values that ranged from 0.44 to 0.82. The lecturers rated all the items above the 2.50 benchmark. The small standard deviation values suggest that the lecturers were homogenous in their ratings. The grand mean of 3.52 implies that lecturers agreed that the items constituted the measures to increase lecturers' application of AI in Biology.

Table 4: Mean and Standard Deviation Ratings of the lecturers on Measures to increase Applications of AI in Biology

S/N	Item Statement	Mean	SD	Remarks
1.	training of lecturers on how to use AI tools in teaching	3.63	0.82	Agree
2.	Provision of AI supporting-facilities in schools	3.49	0.76	Agree
3.	Increasing government funding and support for quality education	3.57	0.44	Agree
4.	Integration of AI in school curriculum	3.71	0.69	Agree
5.	Increasing lecturers' motivation to use AI	3.08	0.82	Agree
6.	Changing the lecturers' orientation in order to embrace AI-based instruction.	3.33	0.65	Agree
7.	Provision of collaboration opportunities for lecturers to acquire more knowledge on AI	3.83	0.53	Agree
	Grand Mean	3.52	0.67	Agree

Discussion

The finding is not in line with Ayanwale, et al, (2022) who found a significant relationship between the attitude and behavioral intention of teachers. The study is not in line with Zawacki-Richter et al. (2019) who reviewed the research of AI in higher education and found out that AI technologies can assist in profiling and predictions in higher education. The finding agrees with Ugwuoti et al. (2023) who investigated the use of AI based tools for Biology education and revealed that there was limited experience and comfort level using AI tools and a need for more education and resources. The study disagrees with Ferikoglu and Argun (2020), who investigated



the AI awareness of teachers in integrating AI in teaching biology and found out that as the level of education increases the awareness of AI also increases. The result is not in agreement with Sanusi et al. (2023) whose studied the context of extracurricular activities in a Nigerian middle school to find out how students engage in machine learning activities and revealed that was evidence of understanding and ethical awareness and students can learn and understand AI while engaging in the AI activities even when one had no prior knowledge or interest in Biology. The study disagrees with Lee et al. (2024) who investigated in service teachers' perception regarding AI for teaching in schools and their teacher training programs and found that teachers hold a favorable attitudes AI education for teaching and their future career. The findings are contrary to those of Garcia-Martinez, et al. (2023) who investigated the impact of AI components on biology students' performance and found that there was a positive impact of AI on students' performance resulting in improvement in the attitude toward learning and motivation. The findings collaborate with those of Davy and Samuel (2021) who investigated fostering relationship following students to pursue their interests in an informal setting and found out that teacher need to build collaborative environment to facilitate social engagement among students. The findings disagree with Chu et al. (2022) who reviewed the top 50 AI in higher education studies in the web of science database from the perspective of highly cited papers and based on a technology-based learning model and found out that predictions of learner's learning status including dropout and retention, student models and academic achievement are mostly frequently discussed in the AI in higher education.

Conclusion

From the findings of the study, it can be concluded that there is negative awareness and attitude of lecturers towards application of AI in teaching Biology. The awareness and attitude of lecturers towards application of AI in teaching could enable lecturers to develop their potentials, think critically and solve problems in Biology. There are a lot of challenges faced when applying AI in teaching Biology such as lack of professional development, infrastructure, curriculum, and funding among others. To overcome these challenges, some measures are suggested such as proper professional development, provision of infrastructure, updating the curriculum, and adequate funding. Based on the findings of this study, the following recommendations are made

1. Nigerian universities should encourage the capacity building and professional development of Biology lecturers.
2. There should be collaboration of lecturers with fellow lecturers to learn new knowledge concerning AI.
3. University communities and administrators should provide adequate infrastructure for AI application.
4. Workshops should be organized for Biology lecturers to enable them to become aware and have positive attitude toward AI.
5. Curriculum planners should integrate AI based learning into Biology curriculum for effective teaching in the classroom.

References

1. Okan, Y. & Anatoli, R. (2023). Artificial Intelligence Literacy teaching on social studies education. *Journal of Pedagogical Research (JPR)*, 7(3), 100-110.
2. Copeland, B. J (2022). Artificial intelligence. Encyclopaedia Britannica. <https://www.britannica.com/technology/artificial.intelligence>.



3. Ferikogu D. & Argun, E. (2022). An investigation of teachers' artificial intelligence awareness. A scale development study. *Malaysian Online Journal of Education Technology (MOJET)*, 10(3), 215-231.
4. Lee, Y. Davis, R.O. & Ryu, J. (2024). Korean-In service teachers' perceptions of implementing artificial intelligence (AI) education for teaching schools and their AI teacher training programs, 2024. *International Journal of Information and Education Technology*, 14(2), 214-219.
5. Awofodu, A.D., Saka, V.O., Olanrele, O. J. & Ogunkomega, F. B. (2020). Influence of cultural practice-related misconceptions on achievement of senior secondary biology students. *African Journal of Science Technology and Mathematics Education (AJSTME)*, Journal of the Department of Science Education, University of Nigeria Nsukka, 5(1), 57-63.
6. Celik I., Dindar M., Muukkonen H. & Jarvela S. (2022). The promises and challenges of artificial intelligence for teachers: A systematic review of research. *TechTrends*, 66(4), 616-630.
7. Sanusi I. T., Olaleye S. A., Oyelere S. S. & Dixon R. A. (2022). Investigating learners' competencies for artificial intelligence education African k-12 setting. *Computers and Education Open*, 3, article no. 100083. <https://doi.org/10.1016/J.caeo.2022.100083>.
8. Tondeur J., Scherer, R., Siddig F. & Baran E. (2020). Enhancing pre-service teacher? technological pedagogical content knowledge CTPACID: A mixed-method study. *Educational Technology Research and Development*, 68(1), 319-343.
9. Eneve I. J., Otti U. P. & Orie, M. J. (2024). Factors inhibiting the integration of educational robots in teaching and learning computer education courses in Universities in Enugu State, Nigeria. *Review of Education*, Institute of Education Journal UNN, 36(1), 149-157.
10. Adebajo, A. A. (2019). Improving students' academic achievement in Biology using information and communication technology guided instruction. *KIU Journal of Social Sciences*, 5(4), 317-326.
11. Davy, T. K. & Samuel, K. W. (2021). Motivating students to learn artificial intelligence through social networking sites: A case study in Hong Kong. *Online Learning*, 25(1), 195-208.
12. Ayanwale, M. A., Sanusi, I. T., Adelana, O. P., Aruleba, K. D. & Oyelere, S. S. (2022). Teachers' readiness and intention to teach artificial intelligence in schools *Computers and Education: Artificial Intelligence*, 3 100099.
13. Seckin, Z., Demirel, Y. & Ozcinar, M. F. (2016). Orgutsel degisim surecinin algılanmasina yonelik betimsel bir arastirma. *Aksaray Universitesi Iktisadi ve Idari Bilimler Fakultesi: Dergisi*, 8(1), 125-134.
14. Zhang, K. & Aslan, A. B. (2021). Artificial intelligence technologies for education: Recent research and failure directions. *Computers and Education: Artificial Intelligence*, 2 100025.
15. Oyelere, S. S., Sanusi, I. T., Agbo, F. J. Oyelere, A.S., Omidiora, J. O. & Adewumi, A. E. (2022). Artificial intelligence in African schools. Towards a contextualized approach in *2022 IEEE Global Engineering Education Conference (EDUCON)*, 1577 - 1782.
16. Simut. R. Simut, C. Badulescu, D. & Badulescu, A. (2024). Artificial intelligence and modelling of teachers' competencies. *Arfiteutru Economic Journal*. The Bucharest University of Economic Studies (Bucharest), 26(65), 181-200.



17. Zawacki-Richter, O., Marin, V. I., Bond, M & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education- where are the educators? *International Journal of Educational Technology in Higher Education*, 16(1), 39. <https://doi.org/10.1186/s41239-0190171-0>.
18. Cabero – Almenara, J. & Costas, J. (2016). Simulators use for students training. *Prisma Social*, 7, 343-372.
19. Luan, H & Tsai C. C. (2021). A review of using machine learning approaches for precision education. *Educational Technology and Society*, 24(1), 250-266.
20. Chu, H., Hwang, G., Tu, Y. & Yang, K. (2022). Roles and research trends in artificial intelligence in higher education: A systematic review of the top 50 most-cited articles. *Australasian Journal of Educational Technology AJET*, 38(3), 22-42.
21. Barbalio, N., Ioannidou, I. Tzionas, P. & Paraskeuopoulos, S. (2013). A model-supported interactive virtual environment for natural resource sharing in environmental education. *Computers and Education*, 62, 231-248.
22. Samuel, M., Iwanger, R. & Apawa U. (2020). Effects of scaffolding instructional strategy, cognitive learning styles and intelligence on students' achievement in genetics in North Senatorial District, Benue state, Nigeria. *International Journal of Advanced Research*, 8(02), 1000-1008.
23. Ugwuoti, O. I., Ugochukwu, M. G., Ugoeze, Q. C. & Ekwe, O.E. (2023). The use of AI based tools for teaching biology. *International Journal of Studies in Education*, 19(1), 1-7.
24. Akgun, S. & Greenhow, C. (2022). Artificial intelligence in education: Addressing ethical challenges in K-12 settings. *AI and ethics*, 2(3), 431-440.
25. European Commission, (2022). *Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators*, Luxembourg: Publications office of European union.
26. Garcia- Martinez, I., Fernandez- Batanero, J. & Fernandez- Cerero, J. (2023). Analysing the impact of artificial intelligence and computational sciences on student performance: Systematic review and meta-analysis. *Journal of New Approaches in Educational Research*, 12(1), 171-197.
27. Gonzalez- Calatayud, V., Prendes- Espinosa, P. & Roig-Vila, R. (2021). Artificial intelligence for student assessment. A systematic Review. *Applied Sciences*, 11(12), 5467 <https://doi.org/10.3390/app11125467>.