ARTIFICIAL INTELLIGENCE FOR EFFECTIVE TEACHING AND LEARNING OF SCIENCE IN COLLEGES OF EDUCATION IN IMO STATE: THE PROSPECT AND CHALLENGES

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ABSTRACT

The study examined the prospect and challenges of artificial intelligence for effective teaching and learning of science in Colleges of Education in Imo State. The study was carried out in Imo State. The targeted population for the study comprised all ICT and science lecturers in colleges of education Imo State. A descriptive survey design was adopted for the study, using a stratified random sampling technique to select 120 ICT lecturers from Imo State College of Education and 120 from Alvan Ikoku Federal College of Education Imo State, this gave a total of 240 respondents used for the study. The instrument used for data collection was a structured questionnaire titled "Artificial Intelligence and Effective Teaching and Learning Questionnaire (AIETLQ)". Face and content validation of the instrument was carried out by an expert in test, measurement, and evaluation in order to ensure that the instrument has the validity and accuracy for the study under consideration. The reliability coefficient obtained was 0.91, and this was substantially high enough to justify the use of the instrument. The researcher subjected the data generated for this study to appropriate statistical technique such as percentage analysis to answer research questions. The findings of the research revealed that 'personalized learning' was the highest prospect of artificial intelligence in effective teaching and learning of science in Imo state Colleges of Education and also that 'inadequate preparedness of teachers' was the major challenge of artificial intelligence in teaching and learning of science in Imo State Colleges of education. The study concluded that by leveraging AI-powered tools and platforms, educators can personalize learning experiences, enhance student engagement, and optimize teaching methodologies to better cater to diverse learning styles. One of the recommendations was that they should be professional development and training programmes for educators to build their capacity for effectively integrating AI tools and resources into science instruction, assessment, and curriculum development.

KEYWORD: Artificial Intelligence, Effective Teaching, Prospect and Challenges

INTRODUCTION

In the last few decades, technology has occupied a commanding position in almost every aspect of human life. Humans cannot imagine a single day without technological interference. The emergence of artificial intelligence (AI) brings new possibilities as well as new challenges to the teaching-learning process (Sen, 2021). Dedicated to molding the next wave of educators, Imo State College of Education is a shining example of Nigeria's educational progress. This college needs to always be looking for new ways to educate and learn, especially in vital subjects like science, if it is to continue pursuing academic greatness. Artificial

intelligence (AI) is a promising new tool that can be used to improve learning and teaching processes as technology develops. Artificial intelligence also known as AI, may be defined as 'man-made thinking power', in which artificial means 'man-made' and intelligence means 'thinking power' (Choudhury, 2022).

With its ability to customize lessons, enhance learning opportunities, and provide educators and students with cutting-edge tools and resources, artificial intelligence (AI) has the potential to completely transform the educational landscape in terms of both teaching and learning effectiveness. AI applications have the potential to significantly alter the field of science education by providing students with more accessible, efficient, and interesting learning opportunities. Natural language processing (NLP) in scientific education has the promise of utilizing AI to improve science teaching and learning at Colleges of Education in Imo State. AI systems can comprehend, interpret, and produce human language by utilizing natural language processing (NLP) methods in research.

But along with the educational potential of AI come certain problems and issues that need to be properly considered. In order to guarantee that the advantages of AI are fairly distributed and successfully achieved, Colleges of Education in Imo State must address concerns about teacher preparedness, ethical considerations, and equity as it considers integrating AI into its pedagogical methods. The study seeks to offer insights and suggestions for utilizing AI to improve educational outcomes while managing the complexities and subtleties inherent in its deployment by looking at the convergence of AI and science education within the framework of the college's mission and goals.

STATEMENT OF PROBLEM

In the ever-evolving landscape of education, artificial intelligence (AI) holds significant promise for transforming science teaching and learning. However, Imo State College of Education faces notable obstacles in fully capitalizing on AI's potential to enhance science instruction. Despite advancements in technology, there exists a conspicuous lack of awareness and integration of AI-powered platforms tailored for science education within the institution. This deficiency extends to the availability and quality of AI-driven educational materials, impacting teaching efficacy and student engagement. Addressing these challenges is imperative for realizing the full potential of AI in augmenting science education. This study aims to identify, analyze, and propose solutions to the multifaceted challenges hindering the integration of AI into science education at Imo State College of Education, thereby contributing to the broader discourse on leveraging AI for educational enhancement.

OBJECTIVES

The objectives of this work were to:

- Examine the prospect of artificial intelligence in effective teaching and learning of science in Imo state Colleges of Education.
- Find out challenges of artificial intelligence in teaching and learning of science in Imo state Colleges of Education.

RESEARCH QUESTIONS

- What are the prospects of artificial intelligence in effective teaching and learning of science?
- What are the challenges of artificial intelligence in teaching and learning of science?

CONCEPT OF ARTIFICIAL INTELLIGENCE

The phrase "artificial intelligence" (AI) now refers to a broad range of technologies that underpin many of the products and services that people use on a daily basis, such as chatbots that offer real-time customer care and applications that suggest TV series. Artificial intelligence, or AI, is a technology that, when used alone or in conjunction with other technologies, allows computers and other machines to mimic human intelligence and problem-solving abilities. Tasks that would normally require human intelligence or intervention can be completed by AI.

Moreover, Copeland (2024) defined artificial intelligence (AI) as the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. The term is frequently applied to the project of developing systems endowed with the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalize, or learn from past experience. Bassey and Owushi (2023) defined artificial intelligence (AI) as "the development of computer systems that can perform tasks that typically require human intelligence."

Additionally, Laskowski (2024) mentioned that artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems. Specific applications of AI include expert systems, natural language processing, speech recognition, and machine vision. In a number of areas, AI can perform tasks much better than humans. Kanade (2022) described artificial intelligence (AI) as the intelligence of a machine or computer that enables it to imitate or mimic human capabilities.AI uses multiple technologies that equip machines to sense, comprehend, plan, act, and learn with human-like levels of intelligence. Fundamentally, AI systems perceive environments, recognize objects, contribute to decision-making, solve complex problems, learn from past experiences, and imitate patterns.

According to Coursera Staff (2024), artificial intelligence (AI) is the theory and development of computer systems capable of performing tasks that historically required human intelligence, such as recognizing speech, making decisions, and identifying patterns. AI is an umbrella term that encompasses a wide variety of technologies, including machine learning, deep learning, and natural language processing (NLP).

In the same vein, Glover (2024) stated that artificial intelligence (AI) is a wide-ranging branch of computer science that aims to build machines capable of performing tasks that typically require human intelligence. While AI is an interdisciplinary science with multiple approaches, advancements in machine learning and deep learning, in particular, are creating a paradigm shift in virtually every industry. Artificial intelligence allows machines to match, or even improve upon, the capabilities of the human mind. From the development of self-driving cars to the proliferation of generative AI tools, AI is increasingly becoming part of everyday life.

CONCEPT OF TEACHING EFFECTIVENESS

Teaching effectiveness is the capability of teachers to teach in such a manner that they achieve success and bring about the desired change in the students' behavior. Umo (2013) as cited in Nyarks and Okey-Agbo (2023) stated that they are difficulties hindering learning. Hence, the need for teachers' dispositions and effectiveness, which determine the quality of a teacher's performance. According to Hawthorne (2022), teaching effectiveness is the knowledge, strategies, processes, and behaviors of teachers that lead to good student outcomes. The Australian Institute for Teaching and School Leadership (2012) defined teaching effectiveness as "both the quality of teaching and the capability of teachers." Teaching effectiveness requires teachers to continually enhance practice by adopting an evaluative mindset. Teaching effectiveness is informed by0 growth-focused evaluations of teaching practice, indicators of learning and wellbeing, and a positive school culture.

Furthermore, Little, Goe, and Bell (2009) mentioned that teaching effectiveness is a teacher's ability to produce gains on student achievement scores, taking account of a baseline measure of students' prior attainment and other characteristics of student intake. According to Jupp (2009), teaching effectiveness is defined as the "practical outputs of teaching." These outputs are quantitative—student learning, as calculated by value-added assessments (which measure how much a specific teacher improves an individual student's learning) or other rigorous measures. And they are qualitative—observations of a teacher's classroom performance by a principal or peer who understands the classroom practices that improve student achievement.

Similarly, Gupta and Verma (2021) defined teaching effectiveness as an area of research that is concerned with the attributes of teachers, the classroom environment, teaching acts, and their effects on the students. Teaching effectiveness is a set of within-person attributes—personality, motivation, beliefs, and

dispositions—that interact with contextual factors (cultural, social, and educational) to influence student outcomes. Teaching effectiveness is a combination of cognitive and non-cognitive attributes such as academic qualification and distinctions, clarity of thought and expression, fluency, teaching strategy, charisma and experience, and socio-personal interaction (Kumari and Padhi, 2014).

CONCEPT OF LEARNING EFFECTIVENESS

When designing learning programs, effectiveness is a very important factor to consider. When learners can retain and access information over long periods of time, it is indicative of effective learning processes. According to Goel (2023), learning effectiveness refers to the ability of a learning program to achieve its intended learning outcomes and produce the desired results. In that sense, a learning-effective program focuses on the quality of learning and the application of that learning to impact performance. An effective program does that by keeping learners engaged, motivated, and participative.

Effective learning refers to a teaching and learning process that not only focuses on the results achieved by students but also emphasizes the understanding, intelligence, perseverance, and quality of learning. It involves creating a comfortable and conducive learning environment, providing necessary facilities and resources, and incorporating research components into the curriculum. Effective learning is characterized by the ability to generate positive feelings and favorable attitudes towards learning, which in turn promotes active engagement and proactive behavior in the learning situation. It also involves strategies such as interrogating information, thinking it through, and organizing and linking concepts (SciSpace, 2023).

Hawthrone (2022) mentioned that learning effectiveness is the knowledge, strategies, processes, and behaviors that lead to good student outcomes. Teacher effectiveness has a positive impact on their students, and they use their expertise to improve learning. These good outcomes are often those that can be measured easily, usually through summative assessment. Effective teaching is constantly recognized as one of the key drivers of school improvement. Learning effectiveness helps students achieve their goals, both personal and academic. It is well known that effective teachers can be hugely influential figures for many young people, providing them with both certainty and assurance when they need it the most.

Davey (2023) stated that the emphasis on learning as an ongoing continuum is crucial for setting expectations around learning outcomes and designing learning experiences that build on one another. Most often, learning effectiveness shows up as a change in behavior, critical thinking abilities, and the application of new knowledge to novel situations. Learners are more likely to be engaged in effective learning in an environment conducive to self-regulation.

THE PROSPECT OF ARTIFICIAL INTELLIGENCE IN EFFECTIVENESS TEACHING AND LEARNING OF SCIENCE

The prospect of artificial intelligence (AI) enhancing the effectiveness of teaching and learning science is a topic of immense interest and significance in the realm of education. With advancements in AI technologies, educators are exploring innovative ways to leverage AI tools to revolutionize science education, making it more engaging, personalized, and effective. Here are the prospects of AI in enhancing the effectiveness of teaching and learning science:

- **Personalized Learning:**

AI-powered adaptive learning systems can tailor educational experiences to the individual needs and learning styles of students. In the context of science education, AI algorithms can analyze students' strengths, weaknesses, and learning patterns to provide personalized learning pathways. For instance, AI-driven platforms can offer customized quizzes, simulations, and interactive exercises based on students' proficiency levels and learning objectives. By catering to each student's unique pace and learning preferences, AI promotes a deeper understanding and retention of scientific concepts (Holmes, 2019).

- **Intelligent Tutoring Systems (ITS):**

Intelligent Tutoring Systems (ITS) are AI-based platforms designed to provide personalized guidance and feedback to students, mimicking the role of human tutors. In science education, ITS can offer real-time assistance and explanations, identify misconceptions, and suggest relevant resources for further study. These systems can engage students in interactive problem-solving activities, simulations, and virtual experiments, fostering active learning and critical thinking skills. Additionally, ITS can track students' progress over time, enabling teachers to intervene when necessary and adjust instructional strategies accordingly (Adams, 2020).

- **Virtual Laboratories and Simulations:**

Virtual Laboratories and Simulations, utilizing AI and computer technology, reimagine the tactile laboratory experience in a digital domain. These simulations offer authentic settings, enabling students to do experiments, alter variables, and examine results without the necessity of physical laboratories. Virtual laboratories provide students with an engaging and immersive learning experience by including interactive elements and prioritizing safety. In addition, they tackle obstacles associated with scarce resources by offering opportunities to conduct experiments and utilize equipment that may otherwise be inaccessible. The diverse and comprehensive utilization of AI in scientific education indicates a transition towards a pedagogical environment that is more responsive to individual student needs, centered on students, and enhanced by technology (Adeyemi, 2020).

- **Natural Language Processing (NLP) in Science Education:**

Natural Language Processing (NLP) technologies enable AI systems to understand, interpret, and generate human language. In the context of science education, NLP-powered chatbots and virtual assistants can interact with students in natural language, answering questions, explaining concepts, and providing additional resources. These conversational agents can offer on-demand support outside the classroom, serving as personalized tutors accessible anytime, anywhere. Moreover, NLP algorithms can analyze students' written responses to open-ended questions, providing automated feedback on their scientific reasoning and communication skills. This advancement has the potential to enhance communication between AI-powered systems and students, resulting in a more authentic and engaged interaction. This, in turn, can contribute to a more comprehensive and immersive learning experience (Aina, 2023).

- **Data Analytics for Learning Assessment:**

Another significant advancement is the anticipated improvement of data analytics. AI-driven data analytics tools can analyze vast amounts of educational data, including student performance metrics, engagement patterns, and learning behaviors. By mining this data, educators can gain valuable insights into students' progress, identify areas of difficulty, and evaluate the effectiveness of instructional interventions. Predictive analytics algorithms can forecast students' future performance and the risk of academic underachievement, enabling early intervention strategies to be implemented. Consequently, this might enable educators and politicians to make better-enlightened judgments by utilizing thorough data analysis (Okeke, 2017).

CHALLENGES OF ARTIFICIAL INTELLIGENCE TO TEACHING AND LEARNING OF SCIENCE

Artificial intelligence (AI) presents both opportunities and challenges in the realm of teaching and learning science. While AI can enhance educational experiences by providing personalized learning, facilitating access to vast amounts of information, and fostering innovative teaching methods, it also poses several challenges that educators must address. Here are the challenges of artificial intelligence to the teaching and learning of science:

- **Limited Ease of Accessibility:**

While there are many benefits AI has to offer, the permanent integration of artificial intelligence in education will lead to limitations for some students. In developed countries, issues like a smartphone, other forms of gadgets, and internet connections that help aid the activities of artificial intelligence are easily accessible. However, for students from developing countries or countries suffering serious crises, this certainly isn't the case. Socio-economic status and geographical location can serve as limitations in the adoption of artificial intelligence in education (Awofiranye, 2024).

- **Inadequate Preparedness of Teachers:**

Additionally, the integration of AI into the educational system will mean that teachers will need to be adequately trained and well-prepared for the purpose to be actualized. Providing adequate training and support for teachers is essential for the successful implementation of AI in education. However, this will not be as easy as it seems; some demands will have to be met. Also, unifying the system means it will have to be adopted globally. Consequently, the educational systems of many countries will not be able to accommodate this development (National Coding Week, 2023).

- **Ethical Issues:**

Another important challenge that will be encountered in adopting AI in the educational system is the issue that concerns ethics and transparency in data collection and use. The integration of artificial intelligence in education raises ethical concerns as AI relies on data to function effectively. On issues like personal data concentration, data privacy and ownership, confidentiality, transparency, and ethics, a lot of work still has to be done.

- **Inability of Students to Explore and Attain Their Full Potential:**

Furthermore, if students become overly dependent on artificial intelligence, it would limit their critical thinking skills and cognitive abilities. Students will become very dependent on machines. This will hinder them from learning what it means to multitask or push themselves to be creative. This therefore limits their ability to attain their full potential and explore their abilities, as their assignments will now be made easier through the use of artificial intelligence.

- **High Cost of Implementation:**

The maintenance of technological devices can be very expensive. The implications of integrating AI into the educational system mean that the education budget of the country will rise. The expenditure on schools will also be on the high side. Countries that cannot adapt to the innovation will end up lagging.

- **Facilitates Technology Addiction:**

Again, the adoption of artificial intelligence in the educational system will in turn foster technology addiction among students and even teachers. Students and teachers will now have to use smartphones, iPads, or laptops for educational activities rather than pen, paper, or books. This will lead to increased screen time and a possible addiction to technological devices.

METHODOLOGY

In carrying out the study, a descriptive survey design was adopted for this study and the study was carried out in Imo State. The targeted population for the study comprised all ICT and science lecturers in colleges of education Imo State. A descriptive survey design was adopted for the study, using a stratified random sampling technique to select 120 ICT lecturers from Imo State College of Education and 120 from Alvan Ikoku Federal College of Education Imo State, this gave a total of 240 respondents used for the study. The instrument used for data collection was a structured questionnaire titled "Artificial Intelligence and Effective Teaching and Learning Questionnaire (AIETLQ)". Face and content validation of the instrument was carried out by an expert in test, measurement, and evaluation in order to ensure that the instrument has the

validity and accuracy for the study under consideration. The reliability coefficient obtained was 0.91, and this was substantially high enough to justify the use of the instrument. The researcher subjected the data generated for this study to appropriate statistical technique such as percentage analysis to answer research questions.

Research Questions 1: The research question sought to examine the prospect of artificial intelligence in effective teaching and learning of science in Colleges of Education in Imo State. To answer the research question, percentage analysis was performed on the data, (see table 1).

Table 1:
Percentage Analysis of the Prospect of Artificial Intelligence in Effective Teaching and Learning of Science in Colleges of Education in Imo State

PROSPECTS	FREQUENCY	PERCENTAGE (%)
Personalized Learning	61	25.42**
Intelligent Tutoring Systems	56	23.33
Virtual Laboratories and Simulations	49	20.42
Natural Language Processing (NLP) in Science Education	44	18.33
Data Analytics for Learning Assessment	30	12.5*
TOTAL	**240**	**100%**

** The highest percentage frequency
* The least percentage frequency

SOURCE: Field Survey

The above table 1 presents the percentage analysis of the prospect of artificial intelligence in effective teaching and learning of science in Colleges of Education in Imo State. From the result of the data analysis, it was observed that the "Personalized Learning" 61(25.42%) was rated as the highest prospect of artificial intelligence in effective teaching and learning of science in Colleges of Education in Imo State, while "Data Analytics for Learning Assessment" 30(12.5%) was rated the least. The result therefore is in agreement with the opinion of Holmes (2019) who posited that AI-driven platforms can offer customized quizzes, simulations, and interactive exercises based on students' proficiency levels and learning objectives. By catering to each student's unique pace and learning preferences, AI promotes a deeper understanding and retention of scientific concepts.

Research Questions 2: The research question sought to find out the challenges of artificial intelligence in teaching and learning of science in Colleges of Education in Imo State. To answer the research question, percentage analysis was performed on the data, (see table 2).

Table 2:
Percentage Analysis of the Challenges of Artificial Intelligence in Teaching and Learning of Science in Colleges of Education in Imo State

CHALLENGES	FREQUENCY	PERCENTAGE (%)	
Limited Ease of Accessibility		51	21.25
Inadequate Preparedness of Teachers		69	28.75**
Ethical Issues		12	5.00*
Inability of Students to Explore and Attain Their Full Potential		48	20.00
High Cost of Implementation		36	15.00
Facilitates Technology Addiction		24	10.00
TOTAL		**240**	**100%**

** **The highest percentage frequency**
* **The least percentage frequency**

SOURCE: Field Survey

The above table 2 presents the percentage analysis of the challenges of artificial intelligence in teaching and learning of science in Colleges of Education in Imo State. From the result of the data analysis, it was observed that "Inadequate Preparedness of Teachers" 69(28.75%) was rated the highest challenges of artificial intelligence in teaching and learning of science in Colleges of Education in Imo State, while "Ethical Issues" 12(5%) was rated the least challenges. The result therefore is in agreement with the research findings of National Coding Week (2023) that stated that the integration of AI into the educational system will mean that teachers will need to be adequately trained and well-prepared for the purpose to be actualized. Which will require the modification of educational systems of many countries to accommodate the development.

CONCLUSION

Integration of artificial intelligence (AI) holds immense promise for revolutionizing the teaching and learning of science at Imo State College of Education. By leveraging AI-powered tools and platforms, educators can personalize learning experiences, enhance student engagement, and optimize teaching methodologies to better cater to diverse learning styles. While there are both prospects and challenges associated with the integration of AI in the teaching and learning of science at Imo State College of Education, the potential benefits far outweigh the risks. By embracing AI technologies responsibly and proactively addressing challenges, educators can unlock new possibilities for enhancing the quality and effectiveness of science education, ultimately empowering students to thrive in an increasingly digital and interconnected world. It is also concluded that there are various prospects of artificial intelligence in effective teaching and learning of science in Colleges of Education in Imo State and the most prominent one is "Personalized Learning". Equally, there are various challenges of artificial intelligence in teaching and learning of science in Colleges of Education in Imo State with "Inadequate Preparedness of Teachers" being the highest challenge.

RECOMMENDATIONS

- Professional development and training programs should be provided for educators to build their capacity for effectively integrating AI tools and resources into science instruction, assessment, and curriculum development.
- They should be development of a comprehensive AI integration strategy aligned with the goals and priorities of Imo State College of Education, encompassing infrastructure development, capacity building, and stakeholder engagement.

- State colleges should establish partnerships with AI technology providers, educational institutions, and government agencies to access funding, technical expertise, and support for implementing AI initiatives in science education.

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