INSTRUCTIONAL METHODS AND GENERATIVE AI INTEGRATION FOR CLASSROOM TEACHING AMONG SECONDARY SCHOOL BIOLOGY TEACHERS IN ILORIN, KWARA STATE

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Abstract
This study investigates the integration of generative AI (GAI) tools in classroom teaching among secondary school Biology teachers in Ilorin, Kwara State, Nigeria, with a focus on their awareness, usage, and the instructional methods employed. A sample of 81 teachers was surveyed to assess their awareness and usage levels of GAI tools and to identify challenges and potential solutions for effective integration. The findings reveal a relatively low overall awareness of GAI tools, with mean awareness scores ranging from 1.6420 to 1.9630, indicating that while some teachers are familiar with GAI, a considerable number lack sufficient knowledge. The usage of GAI tools in teaching is also low, with mean scores ranging from 1.9136 to 2.0741, highlighting a significant gap in practical application. Instructional methods adapted for GAI use showed moderate integration, with mean scores between 1.8519 and 1.9259, suggesting a reliance on traditional teaching approaches. The study found no significant difference in GAI usage between public and private schools, indicating uniform challenges across different school types. Key challenges identified include insufficient training, lack of resources, and inadequate institutional support. These findings underscore the necessity for targeted interventions to enhance the integration of GAI tools, thereby improving instructional methods and educational outcomes in Biology teaching.

Keywords: Instructional methods, Generative Artificial Intelligent, Biology Teachers

Introduction

The world is rapidly advancing, and technology continues to reshape numerous aspects of life, including education. Among these advancements, Artificial Intelligence (AI) stands out as a transformative force, enabling machines to perform tasks traditionally requiring human intelligence, such as teaching, learning, problem-solving, and decision-making. Integrating generative artificial intelligence (GAI) with instructional methods presents an innovative approach to addressing the evolving demands of modern education, particularly in enhancing teaching effectiveness among secondary school biology teachers. Generative AI is one of the many forms of artificial intelligence. An unsupervised or partially supervised machine learning framework, generative AI uses statistics and probabilities to create artificial intelligence artifacts (Baidoo-Anu & Owusu Ansah, 2023). AI technologies have the potential to revolutionize industries, enhance efficiencies, and provide innovative solutions to complex problems. AI is becoming increasingly integrated into everyday life, shaping the way people work, interact, and live while significantly impacting educational systems.

In the context of education, generative artificial intelligence (GAI) refers to the use of AI technologies, such as machine learning and natural language processing, to enhance learning experiences. GAI employs algorithms to analyze data, identify patterns, and make predictions, enabling educators to personalize learning for each student. Additionally, GAI improves student engagement by providing interactive and engaging learning experiences. By leveraging GAI, education can become more accessible and inclusive, offering high-quality learning opportunities to diverse groups of students, including in subjects such as biology (Alexandara, 2023). Biology, as a field of natural science focusing on the study of living organisms, holds a central place in the secondary school curriculum due to its relevance as a life science (Adonu et al., 2021). For students to effectively grasp biological concepts, they require strong retention memory. This retention is significantly influenced by the instructional methods employed in teaching. Instructional methods are strategies, techniques, and approaches used by teachers to promote learning and accomplish specific educational objectives (Anho & Akpokiniovo, 2023). The choice of instructional methods plays a crucial role in determining whether students understand and retain the lessons taught.

Science education, particularly in biology, plays a pivotal role in fostering innovation, critical thinking, and problem-solving skills essential for national development. Biology provides foundational knowledge about living organisms and their interactions with the environment, equipping students with the skills to address pressing global challenges such as environmental degradation, health crises, and biodiversity loss. Effective teaching of biology requires adopting innovative instructional methods to enhance understanding and engagement among students. Traditionally, instructional methods in biology have relied heavily on lecture-based approaches, which, while informative, often limit students' active participation and critical thinking. The emergence of constructivist learning theories underscores the importance of interactive and student-centered teaching methods. Approaches such as inquiry-based learning, problem-solving techniques, and project-based tasks have been shown to improve conceptual understanding and foster scientific inquiry skills. However, integrating these methods into classroom teaching remains a challenge for many biology teachers, particularly in contexts with limited resources and training.

In recent years, the rapid advancement of technology has created new opportunities for transforming instructional practices. Generative AI applications, such as ChatGPT and DALL-E, have emerged as powerful tools in education, supporting biology teaching by generating lesson plans, creating interactive simulations of biological processes, and providing personalized feedback to students. These tools hold the potential to make biology lessons more engaging, contextual, and accessible to diverse learners. However, realizing the full potential of generative AI in biology education requires addressing key challenges. Secondary school biology teachers must acquire the skills and confidence to integrate these tools into their teaching practices effectively. This process necessitates targeted professional development, infrastructure improvements, and strategies for ethical and effective AI use. As the demand for innovative teaching approaches grows, exploring the synergy between instructional methods and generative AI becomes a critical step in elevating the quality of biology education and preparing students for the challenges of the modern world.

Purposes of the Study

1. To access the level of awareness of generative AI among Biology teachers in secondary schools in Ilorin city, Kwara State;
2. To find out the use of generative AI for teaching Biology in secondary schools in Ilorin city, Kwara State;
3. To determine the instructional methods used for generative AI in the teaching of Biology in secondary schools in Ilorin city, Kwara State;
4. To establish significant difference between instructional methods and use of generative AI for teaching Biology in secondary school in Ilorin city, Kwara State.
5. To examine the significant difference between public and private secondary schools ownership on use of generative AI for classroom teaching in Ilorin city, Kwara State

Research Questions

1. What is the level of awareness of generative AI (GAI) among Senior secondary school Biology teachers in Ilorin City, Kwara State?
2. Do Biology teachers use generative AI for classroom teaching in senior secondary schools in Ilorin city, Kwara State?
3. What are the instructional methods employed by Biology teachers when GAI is used for classroom teaching in secondary schools in Ilorin city, Kwara State?

Research Hypothesis

$H0_1$: There is no significance difference between instructional methods and use of generative AI for teaching Biology in secondary schools in Ilorin city, Kwara State.

$H0_2$: There is no significance difference on use of generative AI for teaching Biology between public and private secondary schools in Ilorin city, Kwara State.

Literature Review

Meaning of Artificial Intelligence

Artificial Intelligence (AI) holds immense promise for transforming science education, particularly in the realm of biology, with the ultimate goal of enhancing student retention and academic achievement. Ogunode and Ukozor (2023) defined AI as the ability of machines to perform tasks typically carried out by human intelligence. It is a branch of computer science dedicated to simulating human cognitive processes. In essence, AI involves programming machines to replicate human-like intelligence, enabling them to learn from experience, understand natural language, recognize patterns, and make decisions. This technology has rapidly advanced, catalyzing significant changes across various industries, including education. Within the education sector, AI-driven technologies leverage machine learning algorithms to customize learning experiences based on individual students' needs, preferences, and learning styles, as noted by Olatunde-Aiyedun (2023). By simulating human intelligence processes, AI can personalize learning,

automate administrative tasks, provide real-time feedback, and create immersive learning environments for students.

The transformative potential of AI in education lies in its ability to revolutionize teaching and learning approaches. Through personalized, adaptive, and interactive experiences, AI has the capacity to empower both students and educators. With AI-enabled tools, educators can tailor instruction to meet the unique needs of each student, fostering deeper engagement and understanding. Artificial Intelligence (AI) holds significant potential for enhancing science education, particularly in the teaching of biology, with the aim of promoting retention and academic success among students. Below are some of the ways AI can revolutionize teaching and learning by providing personalized, adaptive, and interactive experiences for students and educators alike.

1. Personalized Learning: AI algorithms can analyze students' learning patterns, preferences, and areas of weakness to tailor instructional content and activities to individual needs. Buckingham et al. (2016) elaborate on how AI can analyse individual student performance, preferences, and learning styles through machine learning algorithms. In biology education, personalized learning can involve adaptive quizzes, customized learning pathways, and targeted remediation activities based on students' performance and comprehension levels. By providing personalized learning experiences, AI can help students engage with biology concepts at their own pace and in a manner that suits their learning styles, thereby enhancing retention and academic success.
2. Adaptive Instruction: AI-powered educational tools can dynamically adjust the difficulty and complexity of learning materials based on students' progress and mastery of biology concepts. For example, intelligent tutoring systems can provide real-time feedback and guidance, adapting their instructional approach to address students' misconceptions and learning gaps. Buckingham et al. (2016) underlined the necessity Nigerian Educational Institutions can use AI to improve scientific instruction by implementing personalized and adaptable methods. This will better prepare students for the changing needs of an AI-driven future. By offering tailored instruction that meets students' individual needs, AI can foster deeper understanding and retention of biology content, leading to improved academic performance.
3. Interactive Learning Experiences: AI technologies, such as virtual laboratories and simulation environments, can provide students with immersive and interactive learning experiences in biology. Virtual reality (VR) and augmented reality (AR) applications powered by AI algorithms can allow students to explore biological phenomena in three-dimensional (3D) environments, visualize complex structures and processes, and engage in hands-on experimentation. By providing opportunities for experiential learning and inquiry-based exploration, AI-enhanced interactive learning experiences can enhance students' understanding and retention of biology concepts.

4. Data-driven Insights: AI can analyze large volumes of educational data to identify patterns, trends, and insights that can inform instructional decision-making in biology education. By leveraging data analytics and machine learning techniques, educators can gain valuable insights into the areas of proficiency and areas of improvement exhibited by their students (Wilson & Thomas, 2021). These insights can help educators design targeted interventions, adapt instructional strategies, and provide personalized support to maximize students' retention and academic success in biology.
5. Continuous Improvement: AI-powered educational platforms and tools can facilitate ongoing assessment and feedback, enabling educators to monitor students' progress, identify areas for improvement, and iteratively refine instructional materials and approaches. By fostering a culture of continuous improvement and innovation in biology education, AI can support educators in their efforts to optimize teaching and learning practices, ultimately leading to enhanced retention and academic success among students.

Therefore, integration of AI into science education, particularly in the teaching of biology, holds immense potential for promoting retention and academic success among students. By providing personalized learning experiences, adaptive instruction, interactive learning environments, data-driven insights, and opportunities for continuous improvement, AI can empower educators to enhance students' understanding and mastery of biology concepts, thereby equipping them with the knowledge and skills needed for academic success in the field of Biology.

Integrating Generative Artificial Intelligence in Teaching Biology Concepts

Biology is generally defined as the scientific study of life and living organisms. It encompasses a vast array of topics, ranging from the molecular mechanisms that govern the functions of cells to the interactions between organisms and their environments. Nwuba & Osuafor (2021) defined Biology as a science subject that deals with the study of living organisms. Biology seeks to understand the structure, function, growth, evolution, distribution, and behavior of living organisms. Biology encompasses a wide range of sub-disciplines, including molecular biology, microbiology, botany, zoology, ecology, genetics, and evolutionary biology, among others. Each sub-discipline focuses on specific aspects of life and employs various methodologies and techniques to explore them. According to Ugwu et al (2020) ascertained that the knowledge of biology has helped immensely in researching solutions to vital concerns such as increasing world food supply, controlling pest and diseases, environmental protection and studying the biology of certain microorganisms such as viruses causing global pandemic like the corona virus among others.

According to Chidozie-Igwe and Marcellinus (2024), noted that teachers of biology have important roles to play in the teaching and learning process; as such, they must be qualified in their field and possess the ability to use a variety of teaching techniques to accommodate the unique needs of each student in the classroom. They go on to say that in order for education to be engaging, fulfilling, and successful for students in Nigeria, teaching credentials in the form of required certificates should not be disregarded. Rather, prospective and current educators who do not meet

the minimum requirements for teaching should make an effort to pursue the necessary training in order to become certified and qualified professional educators. The use of generative artificial intelligence (GAI) in education has gained significant attention worldwide, including in Nigeria. It was further supported by the following authors;

1. Personalized Learning and Adaptive Instruction; AI can facilitate personalized learning by adapting instructional content and pacing based on individual student needs (Aremu & Sokan, 2020). Intelligent tutoring systems can provide scaffold support, guiding students through complex biology concepts and offering real-time feedback. This customized approach can help students grasp and retain biology concepts more effectively.
2. Enhancing learning resources; AI can be used to develop interactive, engaging learning resources, such as simulations and animations, to enhance understanding of biological processes (Egbujie & Ibiam, 2020). These AI-driven tools can complement traditional teaching methods and facilitate a deeper understanding of complex concepts by allowing students to visualize and explore biological phenomena in an interactive manner.
3. Data- Driven Assessment and Feedback; AI- powered assessment tools can provide immediate feedback on students' understanding of biology concepts, allowing educators to identify knowledge gaps and misconceptions (Akintola,2018). By analyzing student performance data, AI systems can help teachers tailor instruction and intervention strategies to improve comprehension and retention.
4. Challenges and Prospects; while integrating AI in biology education holds promise, challenges persist, such as limited access to resources, technology infrastructure, and digital literacy skills among students and teachers (Adeleke & Oluwatayo,2016; Owolabi et al., 2019). Addressing these obstacles is crucial to fully leverage the potential of AI-driven tools and methodologies in Nigerian biology classrooms.

   Integrating GAI into teaching biology concepts, offering prospects for personalized learning, enhanced instructional resources, and data-driven assessment. Future research should focus on addressing the challenges and developing strategies to effectively integrate AI in Nigerian biology education.

Concept of Instructional Methods and Generative AI Integration for Classroom Teaching

In the context of teaching science, especially biology, the concept of instructional methods becomes particularly pertinent. Biology, as a science discipline, involves the study of living organisms, their structures, functions, interactions, and processes. Given its complexity and the vast amount of information involved, employing effective instructional methods becomes crucial in ensuring students grasp key concepts and develops critical thinking skills. Therefore, the success of students in academic subjects, particularly in science disciplines like biology, hinges greatly on the teacher's adeptness in employing suitable instructional methodologies during lesson delivery.

According to Anho & Akpokiniovo (2023) characterize instructional methods as tools utilized in teaching, chosen based on the objectives the teacher aims to accomplish. These methods

encompass a wide array of strategies, techniques, and approaches employed by educators to facilitate learning and achieve desired learning outcomes. Effective utilization of appropriate instructional methods aids students in acquiring a deeper understanding of the subject matter (Tindan et al., 2024). For instance, the lecture method, as identified by Tindan et al. (2024), can be effectively utilized to introduce foundational concepts in biology, such as cellular structure and basic biological processes. Through engaging lectures supplemented with visual aids, instructors can provide students with a comprehensive overview of the subject matter. Similarly, hands-on practical activities and inquiry-based learning can be employed to immerse students in the scientific method and encourage exploration and experimentation. In biology, this may involve laboratory experiments, dissections, or fieldwork, allowing students to apply theoretical knowledge in a practical context and develop essential laboratory skills.

Furthermore, cooperative learning strategies can be utilized to foster collaboration and peer interaction, which are integral to scientific inquiry and problem-solving. Students can work in groups to analyze data, conduct research, or solve complex biological problems, thereby enhancing their communication skills and teamwork abilities. The integration of technology, such as multimedia presentations, interactive simulations, and virtual laboratories, can also enhance the teaching of biology by providing students with dynamic and interactive learning experiences. Technology enables students to visualize complex biological processes, explore virtual environments, and engage with digital resources, fostering deeper understanding and engagement.

Overall, by aligning instructional methods with the unique characteristics of biology as a science discipline and considering factors such as learning objectives, student characteristics, and available resources, educators can create enriching learning experiences that facilitate students' comprehension and mastery of biological concepts. Through effective instruction, students can develop a strong foundation in biology and cultivate a passion for scientific inquiry and discovery.

1. Lecture Method: the lecture method is one of the oldest and the most widely used instructional methods in teaching. In a lecture, the instructor delivers information to students through verbal communication, often accompanied by visual aids such as slides or presentations. The instructors are more active and students are passive. Kapur (2020) describes this method as economical, best used among large number of students and time safer with just the aim of covering the syllabus.

2. Discussion Method: This entails students being engaged in dialogue and debate to explore and deepen their understanding of a topic. Discussion is a situation where students and teacher converse to share information, ideas, or opinions or work to resolve a problem (Dorgu & Ekeke, 2018). Various forms of discussions, including whole-class discussions, small group discussions, and online forums, can be utilized. Active participation, critical thinking, and peer learning are encouraged by this method. However, careful facilitation

may be necessary to ensure that all students have an opportunity to contribute and that the conversation remains focused and productive.

3. Inquiry-Based Learning (IBL): Inquiry-based learning encourages students to actively explore concepts taught through questioning, investigation, and problem-solving. By engaging in hands-on activities, experiments, and real-world applications, students develop a deeper understanding of biological principles (Bondarenko, 2020; Rodrigues, 2017).

Cooperative Learning: Cooperative learning strategies promote peer interaction, collaboration, and shared responsibility in the learning process. Through group discussions, problem-solving tasks, and collaborative projects, students develop communication skills, teamwork, and a sense of collective achievement (Johnson et al., 2014; Sari, 2019; Susuoroka et al., 2023).

Methodology

Research Design

The study adopts a descriptive research design of survey type. Survey method of descriptive study was chosen because of the type of data to be collected through quantitative approach. The descriptive survey method was adopted to obtain information from teachers.

Population of the Study

The population for this study consists of all secondary school Biology teachers in Ilorin City, Kwara State, Nigeria. According to available data, there are a total of 182 Biology teachers in Ilorin City, which includes 164 teachers from public schools and 18 teachers from private schools. For the purpose of this research, a target sample of 81 teachers was selected from the overall population of Biology teachers in Ilorin City. This sample will be utilized to investigate the research questions posed in this study.

Sample and Sampling Techniques

The sample for this study consisted of 81 Biology teachers selected using a stratified random sampling technique to ensure adequate representation from both public and private secondary schools in Ilorin City, Kwara State, Nigeria. Stratification was based on the ownership of the schools, allowing for a comparative analysis of the use of generative AI in teaching practices between public and private institutions. This method of sampling was employed to capture the diverse perspectives and experiences of Biology teachers across different educational contexts, thereby enhancing the validity and reliability of the research findings.

Data Collection Methods

A structured questionnaire was employed as the primary data collection instrument for this study, targeting Biology teachers in secondary schools. The questionnaire was designed with multiple sections, each corresponding to specific research questions related to generative AI awareness, usage, and instructional methods. To measure the level of agreement or disagreement with various statements, a Likert scale was utilized. This scale allowed respondents to express their perceptions and experiences regarding generative AI in their teaching practices. The structured format of the

questionnaire facilitated systematic data collection and analysis, ensuring that relevant information was gathered effectively to address the research objectives.

RESULTS AND DISCUSSION

Presentation of results

Research Question 1: What is the level of awareness of generative AI (GAI) among senior secondary school Biology teachers in Ilorin Kwara State?

T**able 1:** *Awareness level of Generative AI among Biology Teachers*

S/N	Awareness Level of Generative AI Among Biology Teachers	HA	MA	SA	NA	MEAN
1.	Generative AI tools can be used for classroom teaching in Biology	39(48.1)	30(37.0%)	12(14.8%)	0	1.67
2.	Generative AI can simplify instructional delivery process in the classroom	38(46.9%)	35(43.2%)	7(8.6%)	01(1.2%)	1.64
3.	Generative AI have the potentials to concretize abstract concepts in Biology	26(32.1%)	37(45.7%)	13(16.0)	05(6.2%)	1.96
4.	Generative AI could assist in carrying out classroom assignments	29(35.8%)	38(46.9%)	12(14.8%)	02(2.5%)	1.83
5.	Application of Generative AI can promote critical thinking	30(37.0%)	31(38.3%)	16(19.8%)	04(4.9%)	0.88

The findings from table 1 indicates the awareness of generative AI (GAI) among senior secondary school Biology teachers in Ilorin city of Kwara State, the mean values range from approximately 0.88 to 1.96, in which items 3 has the highest mean range while item 5 have the lowest mean range. The total number of 81 biology teachers participated in the study, which the average respondents show moderately level of awareness of generative artificial intelligence.

Research Question 2: Do Biology teachers use generative AI for classroom teaching in senior secondary schools in Ilorin city, Kwara State?

	Usage of Generative AI for Teaching Biology	HU	MU	SU	NU	MEAN
6.	Generative AI tools could be used to present example of abstract concept in my Biology classes	29(35.8%)	29(35.8%)	18(22.2%)	05(6.2%)	1.98
7.	Generative AI could be integrated into the school's Biology practical class.	23(28.4%)	38(46.9%)	11(13.6%)	09(11.1%)	2.07
8.	Generative AI could be used to create educational content for my Biology students	28(34.6%)	37(45.7%)	11(13.6%)	05(6.2%)	1.91
9.	Generative AI could be used to enhance student engagement in Biology lessons.	28(34.6%)	37(45.7%)	09(11.1%)	7(8.6%)	1.93
10.	Generative AI could be used to provide instant feedback for students in Biology.	22(27.2%)	41(50.6%)	11(13.6%)	7(8.6%)	2.03

Table 2: *Usage of generative artificial intelligence for teaching biology*

The above table 2 shows the mean range of respondents on how Biology teachers use generative AI for classroom teaching in senior secondary schools in Ilorin city, Kwara State. The mean range from 1.91 to 2.07 indicating a moderately use generative AI in their various classrooms, with item 3 been the lowest mean range of respondents and item 2 been the highest mean range. The average mean range is moderately use of generative AI among biology teachers in Ilorin city of Kwara State.

Research question 3: What are the instructional methods employed by Biology teachers when GAI is used for classroom teaching in secondary schools in Ilorin city, Kwara State?

Table 3: *Instructional methods for Generative Artificial Intelligence in Biology Teaching*

	Instructional Methods for Generative AI in Biology Teaching	**HU**	**MU**	**SU**	**NU**	**Mean**
11.	Project-based method supports Generative AI for classroom instructional delivery.	31(38.3%)	34(42.0%)	12(14.8%)	04(4.9%)	1.86
12.	collaborative method of teaching enhances the use of Generative AI for classroom instructional delivery	25(30.9%)	45(55.6%)	09(11.1%)	02(2.5%)	1.85
13.	Individualized method of teaching through Generative AI supports the learning pace of individual students.	29(35.8%)	37(45.7%)	12(14.8%)	03(3.7%)	1.86
14.	The adoption of interactive methods while using Generative AI tools facilitate effective learning in students	28(34.6%)	41(50.6%)	07(8.6%)	05(6.2%)	1.86
15.	Every instructional methods can be systematically integrated into classroom teaching through the use of Generative AI tools	31(38.3%)	31(38.3%)	13(16.0%)	06(7.4%)	1.93

The result in Table 3 shows the instructional methods employed by Biology teachers when GAI is used for classroom teaching in secondary schools in Ilorin city of Kwara State, the mean range indicates item 2 with lowest mean score and item 5 with the highest mean score. The mean ranges between 1.85 and 1.9. This indicates that Biology teachers moderately use generative AI in their various classrooms for disseminating information.

The following null hypotheses was analyzed as show below;-

Research Hypothesis

$H_0$1: There is no significance difference between instructional methods and use of generative AI for teaching Biology in secondary schools in Ilorin city, Kwara State.

Table 4: *T-test analysis of significant difference between instructional methods and use of generative AI for teaching Biology in Secondary Schools in Ilorin city, Kwara State*

	t	df	Sig(2-tailed)	Mean	Lower	Upper
INSTR.	27.097	80	.000	9.373	8.682	10.058
USAGE	24.652	80	.000	9.951	9.147	10.754

P <0.05

From table 4 of t-test analysis, the results show that p-value calculated is less than the critical value of 0.05 thereby rejecting the null hypothesis, which would be that there is no significance difference between instructional methods and use of generative AI for teaching Biology in secondary schools in Ilorin city, Kwara State. Instead, the evidence suggests that there is indeed significance difference between the two variables. Therefore, instructional methods have significant difference between instructional methods and how generative AI is utilized in teaching Biology.

Research question 2:

$H_0$2: There is no significant difference in the use of generative AI for teaching Biology between public and private secondary schools in Ilorin city, Kwara State.

Table 5: *T-test analysis of significant difference in the use of generative AI for teaching Biology between public and private secondary schools in Ilorin city, Kwara State*

	t	Df	Sig(2-tailed)	Mean	Lower	Upper
USAGE	24.652	80	.000	9.951	9.147	10.754
TI	25.858	80	.000	1.432	1.322	1.542

P <0.05

From table 5 of t-test analysis, the results show that p-value calculated is less than the critical value of 0.05 thereby rejecting the null hypothesis, which would be that there is no significance difference in the use of generative AI for teaching Biology between public and private secondary schools in Ilorin city, Kwara State. The data strongly indicate that there are significant differences in how generative AI is utilized between public and private schools in the context of teaching Biology.

Discussion of findings

The study examined instructional methods and generative AI integration for classroom teaching among secondary school Biology teachers in Ilorin, Kwara State. The data shows that a significant

proportion of teachers are either highly aware or moderately aware of GAI, yet there remain notable percentages that are slightly aware or not aware at all. This suggests that while some educators are familiar with GAI, a considerable number lack sufficient knowledge, highlighting a need for targeted awareness programs. The findings also indicate a generally low usage of GAI tools for teaching purposes among the surveyed Biology teachers. The mean scores for usage ranged from 1.9136 to 2.0741, with a consistent presence of slight to moderate usage levels. Despite some teachers utilizing GAI tools, the data shows a significant portion of teachers are not integrating these tools into their teaching practices effectively. This low adoption rate may be attributed to factors such as insufficient training, lack of resources, or limited understanding of how to effectively implement GAI tools in educational settings.

Furthermore, the instructional methods employed when using GAI tools, the mean scores suggest a moderate level of adaptation. The instructional methods' mean scores ranged from 1.8519 to 1.9259, with standard deviations indicating moderate consistency. The relatively low means point towards a limited integration of innovative instructional methods that leverage GAI. The data suggests that while some teachers are adopting new methods, many are still relying on traditional teaching approaches, potentially due to a lack of training or confidence in using GAI technologies.

Conclusion

The study reveals that while there is a moderate level of awareness of GAI among secondary schools Biology teachers in Ilorin, the actual usage of these tools in teaching is relatively low. The instructional methods currently employed are still largely traditional, with only moderate integration of GAI. The significant difference observed in GAI usage between public and private schools suggests that targeted interventions are needed to ensure equitable access to these technologies across different school types. To fully harness the potential of GAI in enhancing Biology education, there is a need for increased awareness, better resources, and robust institutional support. By addressing these areas, educational outcomes in Biology can be significantly improved, leading to better student engagement, understanding, and retention.

Recommendations

Based on the findings of this study the following recommendations were made;

1. Regular and comprehensive training workshops should be organized for biology teachers to increase their awareness and proficiency in using GAI tools. These programs should cover the basics of AI, its application in education, and hands-on experience with GAI tools.
2. Schools should be equipped with the necessary technological resources, including computers, reliable internet access, and GAI software, to enable teachers to effectively implement these tools in their classrooms.
3. Educational institutions should develop clear policies and provide support structures that encourage the use of GAI in teaching. This could include creating AI research centers and fostering partnerships with AI industry leaders to stay updated on the latest developments.

4. Financial and professional incentives should be provided to teachers who actively integrate GAI tools into their teaching practices. This could motivate more teachers to explore and utilize these technologies.
5. The integration of GAI should be systematically embedded into the biology curriculum, ensuring that instructional methods are aligned with the capabilities of GAI to enhance student engagement and understanding.

References

Adebisi, R.,O., Adeyemi, M., I., & Umbuagada M., A. (2021). Science Learning Performance and Retention of Biology Concepts among Secondary Students. *Journal of Biological Science and Education*, 3(1), 22-30

Adeleke, O. A., & Oluwatayo, A.A. (2016). Availability and utilization of instructional materials in teaching and learning of biology in secondary schools. *Aquademia Journal of Education,* 1(2), 22-26

Adonu, C., J., Nwagbo, C., R., Ugwuanyi, C., S., & Okeke C., I., O. (2021) Improving Students' Achievement And Retention In Biology Using Flipped Classroom And Power point Instructional Approaches: Implication For Physics Teaching. *International Journal of Psychosocial Rehabilitation,* 25(02), 234- 247

Akintola , D.A. (2018). The status of biology in Nigerian secondary school curriculum; Implications for scientific literate society. International Journal of Education and research, 6(3), 167-178

Alexandara, Harry (2023), Role of AI in Education, *Injurity Interdisciplinary Journal and Humanity*, 2(3), 260-268

Anho, o., r, Akpokiniovo, R., S. (2023). Teaching Methods and Teachers Conference/Seminar Attendance: The Gateway to Quality Education in Nigeria. *International Journal of Social Science and Education Research Studies,* Vol 3 (4) 619-625. DOI: https://doi.org/10.55677/ijssers/V03I4Y2023-12

Aremu, A. O., & Sokan, A. O., (2020). Integrating of Computer and Internet Facilities in Teaching and Learning Biology in Colleges of Education in Oyo State, Nigeria. International Journal of research & review, 21(1). 521-524

Buckingham Shum, S., & Ferguson, R. (2016). Social Learning Analytics. In J. Gardner & M. G. Potosky (Eds.), Learning Analytics in Higher Education: Current

Baidoo-Anu, D., & Owusu Ansah, L. (2023). Education in the Era of Generative Artificial Intelligence (AI): Understanding the potential Benefits of ChatGPT in promoting Teaching and Learning. Journal of AI 7(1), 52-62

Chidozie-Igwe, N., & Marcellinus, C., A., (2024), Biology Teachers' Awareness of Innovative Teaching Strategies in Bwari Area Council, Abuja. Kashere Journal of Science and Education 2024, 2(1); 100-108

Dorgu, T., E. & Ekeke., J. H. (2018). Effectiveness of Discussion Method of Teaching in Curriculum Delivery in Secondary Schools in Bayelsa State of Nigeria. Saudi Journal of Humanities and Social Science, Vol. 3, (9) 1096-1102.

Egbujie, C. A., & Ibiam, A. C., (2020). Teaching and Learning of biology in Nigeria; A platform for effective collaboration between researchers and educators. Nigerian Journal of Sciences and technology, 21(1), 55-61

Freeman, S., Eddy, S.L., McDonough, M., Smith, M. K.,Okoroafor, N., Jordt, H., & Wenderoth, M.P.(2014). Active Learning Increases Student Performance in Science, Engineering, and Mathematic. Proceedings of the National Academy of sciences, 11(23), 8410-8415

Gogoulou, A., Meletiou-mavrotheris, M., & Stavarakis, E.(2020). Use of Artificial Intelligence in Biology Teaching; An Integrative review. Education and Information Technologies, 25(3), 2183-2209.

Innovations, Future Potential. *International Journal of Artificial Intelligence for Digital Marketing*, Vol. 1(249–272).

Kapur, Radhika. (2020). Lecture Method: The Comprehensively used Pedagogical Method.

Nwuba, I., & Osuafor, A. (2021). Effect of experiential learning approach on secondary school students' academic achievement in biology in Awka Education Zone. *South Eastern Journal of Research and Sustainable Development*, 4(2), 1-15

Ogunode, N,. J. & Ukozor, C,. U. (2023). Curriculum Revolution in Higher Education: The Mighty Role of Artificial Intelligence. *Indonesian Journal of Innovation Studies*, Vol. 25, 6-11.

Ogunode, N., J. & Abiodun, O., J. (2023). AI Education in Nigeria Schools. *International Journal of Human Computing Studies,* Vol. 05 10. 47-48.

Olatunde-Aiyedun, T., G. (2023). Artificial Intelligence in Education: Integration of AI into Science Education Curriculum in Nigeria Universities. *International Journal of Artificial Intelligence for Digital Marketing*, Vol. 1 (1)

Olorundare, A., S., (2014). Theory into practice: Beyond surface curriculum in science education. The one hundred and forty-seventy (147^{th}) inaugural lecture. Unilorin press

Okoyefi, Q. O. (2014). Effect of four mode applications techniques on achievement, retention and multiple intelligences of students with different learning styles in biology.(Unpublished Phd Thesis). University of Nigeria Nsukka

Owolabi, A.A., Olayinka, S. A., & Joshua, M. O., (2019). Nigerian pupils' understanding of selected biological concepts. Asian Research Journal of Biological Sciences, 2(2),1-10.

Somyurek, S., & Atas, D., (2020). The Use of Artificial Intelligence for Learning in Science Education. *Universal Journal of Educational Research*, 8(3), 1274-1281

Tindan, Thomas & Sharifatu, Amadu & O. Kwakye, D.. (2024). Evaluation of the Teaching Methods Used in Teaching Senior High School Biology. *International Journal for Multidisciplinary Research*, 6. 1-10.

Ugwu, L., Jatau, A., & Gwamma, S., K. (2020).Impact of Discussion Method on Performance and Retention in Biology among Senior Secondary Students in Katsina Education Zone, Katsina State, Nigeria. *International Journal of Multidisciplinary and Current Educational Research* 2(6) 76-83

Wilson, E., & Thomas, G. (2021). Leveraging AI for Data-driven Decision-Making in Education: Opportunities and challenges. *Educational Technology & Society*, 24(3), 45-57.