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Barriers to Incorporating Artificial Intelligence in Chemistry Instruction in Post-Primary Education in Orlu Education Zone II, Imo State

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Abstract
This study aimed to determine the impediment to the incorporation of Artificial Intelligence in Chemistry Instruction in Post-primary education in Orlu Education Zone II, Imo State. A descriptive survey research design was adopted in conducting this research. The population of the study comprises of Chemistry teachers from all the 41-government owned post primary schools in Orlu Education Zone II. A census sampling technique was employed which constitutes 41 chemistry teachers comprising 16 males and 25 females. Data were gathered using a four-point Likert questionnaire instrument with a reliability coefficient of 0.71 ascertained using test-retest methodology. The t-test, mean, and standard deviation statistical tools were used to assess the generated data at the 0.05 level of significance. Two research questions and one hypothesis guided the study. The findings indicated a lack of technical assistance, training and resources, low computer self-efficacy, opposition to innovation, and lack of AI knowledge which obstructed the incorporation of Artificial Intelligence in chemistry instruction in post-primary education. In light of the results, attending workshops and seminars was advised for chemistry teachers in order to foster a positive knowledge about AI, increase their computer self-efficacy, and demonstrate an interest in innovation towards AI in chemistry instruction in post-primary education in Imo state.

Keywords: Impediments, Incorporation, Artificial Intelligence, Chemistry instruction, Teachers

Introduction

Chemistry is always studied in any of its numerous sub-disciplines since it provides an introduction to a wide range of fundamental principles that students can utilize to obtain tools and abilities at the advanced levels Okore et al. (2023). Chemistry education and practice are utilizing digital technologies and virtual approaches to improve students' interest. Chemistry instruction can be done either physically or virtually. The incorporation of Artificial Intelligence (AI) in education has been a growing trend in recent years. With the potential to revolutionize teaching and learning processes in chemistry, AI offers numerous benefits, such as personalized learning experiences, real-time feedback, and the ability to adapt to individual student needs. Artificial Intelligence can be used to enhance student understanding of complex concepts, provide real-time feedback on performance, and generate custom learning pathways based on student progress (Olatunde-Aiyedun & Hamma, 2023). Chemistry is a subject where complicated correlations are frequently found in data sets, hence it is feasible to apply AI to a variety of jobs in this field. For instance, one can use theoretical calculations or equations based on empirical data to forecast the solubility of a new molecule, for instance. While artificial intelligence (AI) and its applications in chemistry have received a lot of attention, the abundance of available data makes it difficult to understand how AI is being used and developed in the field. To improve student learning and engagement, chemistry teachers can utilize a variety of AI tools in the classroom and some examples of these AI tools includes: Chemix, Chem101, Labster, Nanome, ChemAlive etc. Chemix is a virtual lab platform that uses AI simulations to replicate real-world lab experiences, enabling students to explore chemical reactions, practice laboratory techniques, analyze data in a hands-on setting and allows students to conduct chemical experiments in a safe and interactive online environment. Chem101 is another AI-powered digital learning platform that offers personalized study plans, interactive tutorials, and adaptive assessments for chemistry students. The platform uses AI algorithms to assess student performance, identify areas for improvement, and provide targeted practice activities to help students master chemistry concepts.

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Labster is a virtual lab simulation platform that uses AI technology to create immersive, 3D laboratory experiences for students. The platform offers a wide range of virtual experiments, interactive simulations, and gamified learning activities designed to deepen student understanding of chemistry principles. Nanome is a molecular visualization and modelling platform that uses AI algorithms to create 3D representations of chemical structures and molecules. The platform allows students to manipulate and interact with molecular models in real time, fostering a deeper understanding of molecular geometry, bonding, and chemical properties. ChemAlive is an AI-driven platform that offers quantum chemistry simulations and calculations for students and researchers. The platform uses AI algorithms to predict molecular properties, simulate chemical reactions, and analyze chemical structures, providing valuable insights into the behaviour of atoms and molecules (Olatunde-Aiyedun & Hamma, 2023). The extensive use of AI in chemistry instruction in post-primary education is nevertheless hampered by a number of impediments, notwithstanding these benefits. The deficiency of infrastructure and resources in schools is one of the primary barriers to the incorporation of AI in chemistry instruction. Many schools lack the resources and technology needed to enable AI-driven learning tools (Olatunde-Aiyedun, 2024). Teachers also lack the assistance and training they need to incorporate AI into their lessons. It can be difficult for schools to integrate AI into chemistry education without the right framework and assistance. Another impediment to the incorporation of AI in chemistry education is the lack of awareness and understanding among educators and policymakers. Many teachers and administrators may be unfamiliar with AI technologies and their potential applications in education. As a result, there may be resistance to adopting AI in the classroom due to a lack of knowledge about its benefits and implications for teaching and learning (Afolabi & Oluwatimilehin, 2021). Concerns exist regarding the ethical ramifications of utilizing AI in education as well, mainly with regard to student security and data privacy. When integrating AI into chemistry education, educators and legislators need to be aware of these issues and make sure that the right security measures are in place to protect student privacy. In order to overcome these impediments and facilitate the incorporation of AI in chemistry education, there is a need for increased investment in technology infrastructure, training and support for teachers, and awareness-building initiatives among educators and policymakers. By addressing these challenges, schools can take full advantage of the potential benefits of AI in chemistry instruction and enhance student learning outcomes in the field of chemistry.

There are specific AI technologies that have already been successfully implemented in chemistry education which include Smart Sparrow, Assessment and Learning in Knowledge Spaces, and Pearson's Mastering Chemistry, Smart Sparrow's adaptive learning platform offers personalized, interactive courses that adapt to individual student performance and learning styles (Holmes, 2019). In the context of chemistry education, instructors can create custom learning modules that provide real-time feedback, adaptive assessments, and personalized study recommendations to help students master complex chemistry concepts. Another example is Assessment and Learning in Knowledge Spaces (ALEKS), which is widely used in higher education for mathematics and chemistry courses. It uses AI algorithms to assess student knowledge, identify areas of strength and weakness, and provide targeted instruction and practice activities to improve student understanding of chemistry topics. Pearson's Mastering Chemistry is another popular adaptive learning platform that offers a comprehensive suite of digital tools, interactive simulations, and adaptive assessments to enhance student learning in chemistry courses (Olatunde-Aiyedun & Hamma, 2023). The platform tracks student progress, provides immediate feedback on assignments, and offers personalized study plans based on individual performance data. While the integration of AI in teaching chemistry offers numerous benefits, there are several challenges and impediments that educators may face in incorporating AI technologies into the curriculum. Some of the key impediments include Cost and Resources: Implementing AI tools and platforms in schools can be costly, both in terms of acquiring the technology and providing training for teachers to effectively use these tools. Many schools may not have the financial resources or technical expertise required to invest in AI solutions for teaching chemistry. Access and Infrastructure: Access to reliable internet connectivity, devices, and technical infrastructure is essential for leveraging AI tools in the classroom. Schools in underserved areas or with limited access to technology may face challenges in effectively implementing AI in teaching chemistry. Lack of Awareness and Understanding: Educators and school administrators may have limited knowledge and understanding of AI technologies and their potential applications in teaching chemistry. There may be a need for professional development and training to build capacity among teachers and staff to effectively incorporate AI tools into the curriculum. Privacy and Data Security Concerns: AI tools in education often collect and analyze student data to personalize learning experiences. Schools must adhere to strict data privacy regulations and ensure the security of student information when using AI technologies, which can be a significant challenge (Ojelade et al., 2020).

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Resistance to Change: Introducing AI tools in the classroom may face resistance from stakeholders, including teachers, parents, and students, who may be hesitant to embrace new technologies or fear that AI will replace traditional teaching methods. Overcoming these impediments requires collaboration, investment in infrastructure and training, clear communication and support from stakeholders, and a strategic approach to implementing AI technologies in teaching chemistry effectively (Afolabi & Oluwatimilehin, 2021). By addressing these challenges, schools can harness the power of AI to enhance student learning experiences and improve outcomes in chemistry education. Wang-Kin (2021) reviewed on the use of artificial intelligence technologies in chemistry education. This involved the analysis of up to 45 papers indexed in Web of Science, Scopus and for the period of 2010 to 2021. The review provided evidence that there was application of artificial intelligence in chemistry education such as virtual reality and augmented reality, with a major focus on virtual chemistry and hands-on class activities. Dermot et al. (2011) proposed a virtual chemistry laboratory for science-based inquiry and also a review of the science syllabi for Turkish schools to address the efficient use of Information Technology in schools. Jose et al. (2023) attempted to construct a design for continuous training of in-service teachers through the use of Instructional Design (ID) and Technological Pedagogical Science Knowledge (TPASK). Swati et al. (2024) studied on the use of augmented reality for chemistry instruction to ease the ability of students to access textbooks in a digitized smart way and make the class more interactive and fun. David and Potier (2023) applied a guided inquiry approach for practical activity in UK schools which provided an opportunity for students to practice titration on their own successfully with this method.

Nimesh et al. (2021) developed the virtual approach in organic chemistry instruction which was necessitated by the Covid-19 pandemic. Nurul et al. (2021) carried out research aimed at eliciting information from teachers about the use of virtual STEM laboratories in augmenting chemistry instruction, with the result showing that all the teachers were very positive about the objective. Firmanul et al. (2021) studied the application of a virtual laboratory to teach microscopic physics topics like electrical energy in the dry cell and implied that it helped to overcome difficulty in mastery of abstract concepts among students. Dinda et al. (2021) studied the application of an inquiry-based virtual laboratory for teaching chemistry, by making use of pre-tests and post-tests and discovered that students taught in this way developed competence in constructing hypotheses, conclusions and communication in contrast to the students who were taught using the traditional method.

Statement of the Problem

Artificial Intelligence (AI) has the potential to revolutionize the teaching and learning of complex subjects like chemistry by enabling personalized learning, automating routine tasks, and improving the overall effectiveness of instruction. However, the integration of AI in chemistry instruction in post-primary schools in Orlu Education Zone II, Imo State, is facing significant challenges. The majority of chemistry teachers in the region lack sufficient knowledge and training in AI tools, leading to a low adoption rate. Infrastructure in these schools is inadequate, with poor access to AI-related resources like computers, software, and reliable internet connectivity. Additionally, the curriculum does not emphasize AI, leaving teachers without the support needed to incorporate AI effectively. These barriers are not only hindering the potential for innovation in teaching but also negatively affecting students' engagement and performance in chemistry.

Aim and Objective of the Study

The aim of the study is to investigate impediments to the incorporation of artificial intelligence in chemistry instruction in post-primary education in Orlu Education Zone II, Imo State. Specifically, the study sought to:

- Determine the teachers perceived factors hindering the integration of AI in teaching chemistry in post-primary education in Orlu Education Zone II, Imo State.

Research Question

- What are the teachers perceived factors hindering the integration of AI in teaching chemistry in post-primary education in Orlu Education Zone II, Imo State?

Hypothesis

The study was guided by this hypothesis.

$H0_1$: There is no significant difference between the mean perception of male and female teachers on the factors hindering the integration of AI in teaching and learning of chemistry in post-primary education in Orlu Education Zone II, Imo State.

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Methodology

The study was carried out using the descriptive survey design. This was adopted to determine the true perceptions of teachers on the factors hindering the incorporation of AI in chemistry classrooms. The population consists of all the chemistry teachers from all the 41 government-owned post-primary schools in Orlu Education Zone II, Imo State. The sample consists of the entire population, it consists of 16 male and 25 female teachers totaling 41 teachers. The sampling technique employed is the census sampling technique since the population is small. The instrument for data collection was researchers Likert's four-point type of questionnaire titled "Factors Hindering AI Integration in Chemistry Classroom" (FHAIICC) it was divided into two sections. Section A focused on the demographic variables of the respondents while section B examined the factors teachers said were impeding the integration of AI in chemistry instruction in post-primary schools. The instrument was validated by experts in chemistry and measurement and evaluation. The test-retest method was used to assess the instrument's reliability. The reliability coefficient of 0.78 for the instrument was deemed suitable for the study. The selected sample of respondents received the instrument, completed it, and returned it to the researcher. At the 0.05 level of significance, the data was analyzed using statistical methods such as the mean, standard deviation, and t-test. Any item mean that was 2.5 or higher was considered a factor, but any value below that was rejected.

Results

Research Question 1: What are the teachers perceived factors hindering the integration of AI in teaching chemistry in post-primary schools?

Table 1: Mean Responses on the teachers' perceived factors hindering the integration of AI in teaching Chemistry.

		Male			**Female**		
S/N	Items	Mean	SD	Remarks	Mean	SD	Remarks
1.	Lack of Available computer software for exploring AI tools.	2.94	2.60	Agree	3.96	2.12	Agree
2.	Lack of training on AI usage and professional development on AI technology	3.31	2.78	Agree	2.96	2.62	Agree
1.	Resistance to change and fear of technology replacing traditional teaching methods	3.31	3.42	Agree	2.84	2.55	Agree
4.	Difficulty in understanding and incorporating AI algorithms and data analysis in the chemistry curriculum	2.94	2.60	Agree	3.12	2.70	Agree
5.	Lack of awareness about the potential benefits of integrating AI in teaching chemistry	2.56	2.92	Agree	2.92	2.59	Agree
6.	Low computer self-efficacy, opposition to innovation and AI knowledge	3.25	2.85	Agree	2.92	2.62	Agree
7.	Budget constraints for purchasing and maintaining AI equipment in chemistry labs do not give schools the opportunity to afford such gadgets.	3.13	2.74	Agree	3.04	2.68	Agree
8.	Inadequate communication and collaboration between chemistry teachers and AI experts in implementing new technologies.	3.13	2.78	Agree	3.08	2.77	Agree
9.	Lack of technical assistance on the use of AI tools.	3.25	2.85	Agree	3.16	2.81	Agree
10.	Poor electricity system and poor payment structure of teachers.	2.81	2.53	Agree	3.00	2.34	Agree
	Grand Mean	3.06	2.30	Agree	3.39	2.58	Agree

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In Table 1 above, all 10 items amounted to the noticeable challenges to AI incorporation in chemistry instructions. The mean values indicate that the chief barriers include: lack of technical assistance, training and resources, low computer self-efficacy, opposition to innovation, and lack of AI knowledge. The grand mean value of 3.01 is a serious overall indication that AI incorporation into chemistry instructions in post-primary education is facing a lot of impediments. These impediments account for the chemistry teachers' ill feelings and are rigid to the change brought by Artificial Intelligence.

Table 2: Summary of mean responses between male and female chemistry teachers.

TEACHERS	N	MEAN	SD	DIFFERENCE IN MEAN
Males	16	3.06	2.30	0.33
Female	25	3.39	2.58	

Table 2 shows that a mean difference of 0.33 exists in the perception of male and female teachers on the impediments obstructing the incorporation of AI in teaching chemistry. The difference is in favour of the female teachers.
$H0_1$: There is no significant difference between the mean perception of male and female teachers on the factors hindering the integration of AI in teaching and learning chemistry.

Table 3: Summary of t-test analysis on male and female teachers' perceptions.

Teachers	N	Mean	SD	Df	t-cal	α	t-tab
Males	16	3.06	2.30	39	0.71	0.05	2.02
Females	25	3.39	2.58				

The results in Table 3 show that the calculated value (0.71) is less than the Table value (2.02), this implies that the two means do not differ significantly, therefore, we do not reject the null hypothesis.

Discussion

The results of the study revealed that, irrespective of the great contributions attributed to AI in chemistry instruction at the post-primary education level, a series of factors still prevent the full incorporation. These factors include lack of training on AI usage and professional development on AI technology, low computer self-efficacy, opposition to innovation and AI knowledge, lack of technical assistance on the use of AI tools, resistance to change and fear of technology replacing traditional teaching methods etc. This result is in agreement with the report of Olatunde-Aiyedun (2024) which outlined these factors as barriers to the successful integration of AI in teaching and learning environments.

The study also revealed that no statistical difference in the perceptions of male and female teachers on the factors obstructing the integration of AI in teaching chemistry. The result of this study conforms with the findings of Abdulla (2023) whose work indicated no difference in teacher responses based on the variables; gender, teaching experience, and qualifications regarding teachers' behavioural intentions to actually use AI in science teaching.

Conclusion

The study was carried out to determine the impediments to the incorporation of AI in chemistry instruction in post-primary schools. The findings revealed that irrespective of the burning desire to integrate AI in teaching chemistry in post-primary schools, a number of impediments still stand as a barrier. These impediments among other things include teachers' lack of training on AI usage and professional development on AI technology, low computer self-efficacy, opposition to innovation and AI knowledge, lack of technical assistance on the use of AI tools, resistance to change and fear of technology replacing traditional teaching methods. These impediments are not gender biased as revealed by the study.

Recommendations

It is important for the school administration to handle the school affairs effectively especially when it has to do with accepting trending teaching gadgets and modern teaching methodology, especially for chemistry teachers. Therefore, the researchers proffered the following recommendations.

1. Teachers should be exposed to workshops, seminars and training on AI usage and professional development on AI technology to foster a positive knowledge about AI.

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2. There should be constant light or stand-by generators in schools where these AI gadgets are installed to ensure there is regular usage of AI gadgets to create AI mastery.
3. There should be adequate manpower and AI tools supply in the schools through the government to create positive collaboration among teachers towards incorporating AI tools in teaching chemistry.
4. Teachers should demonstrate an interest in innovation towards AI in chemistry instruction to increase their computer self-efficacy.

References

Abdulla, A. I. D. (2023). Acceptance of artificial intelligence in teaching science: Science teachers' perspective. *Computers and Education Artificial Intelligence 4*(8):100132 DOI:10.1016/j.caeai.2023.100132

Afolabi, M. O., & Oluwatimilehin, T. F. (2021). Artificial intelligence in Nigerian higher education: opportunities, challenges, and the way forward. *Journal of Educational Technology Systems, 49*(1), 85–107.

David, N., & Potier. (2023). The use of guided inquiry to support student progress and engagement in high school chemistry. *Journal of Chemical Education, 100*(2):1033-1038. doi: 10.1021/acs.jchemed.2c00793

Dermot, F. D., John, O., & Oliver, M. (2011). *The promotion of scientific inquiry in Irish post-primary schools through the use of a virtual chemistry laboratory, implications for teacher education.*

Dinda, N. M. I., & Sri, Atun. (2021). The impact of inquiry-based virtual laboratory on students' inquiring abilities. *MIER Journal of Educational Studies, Trends and Practices, 9*(1):50-61. doi: 10.52634/MIER/2019/V9/I1/1377

Firmanul, C. W., Agus, S., Dina, R. D., Andi, S., Achmad, S. M., Noor, F., Supriyatman., N. Anriani., Soffan, N., Moh, F., Farouq, P. A. P., & Niki, D. P. (2021). *Effectiveness of virtual physics laboratory (VPL) with dry cell microscopic simulation (DCMS) to promote of inquiry activity about the battery*. (IOP Publishing), 1772(1):012006-. doi: 10.1088/1742-6596/1772/1/012006

Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial intelligence in education: promises and implications for teaching and learning.* Boston: Boston Consulting Group.

José, H., Jorge, R., Lizethly, C., & Maija, A. (2023). Constructing a novel e-learning course, educational computational chemistry through instructional design approach in the TPASK framework. *Education Sciences, 13*(7):648-648. doi: 10.3390/educsci13070648

Nimesh, M., & Namrah, S. (2021). Design and delivery of virtual inquiry-based organic chemistry experiments. *Journal of Chemical Education, 98*(9):2952-2958. doi: 10.1021/ACS.JCHEMED.1C00571

Nurul, F. R., Sri, R. D. A., Sri, M., & Nurma, Y. I. (2021). Chemistry teachers' perspectives on virtual STEM laboratories as learning media. *(Atlantis Press)*, 627-633 doi: 10.2991/ASSEHR.K.210326.091-

Ojelade, I. A., Aregbesola, B. G., Ekele, A., & Aiyedun, T. G. (2020). Effects of audio-visual instructional materials on teaching science concepts in secondary schools in Bwari Area Council Abuja, Nigeria. *The Environmental Studies Journal (TESJ), 3*(2) 52 – 61.

Okore, G., Ibe, C., Ogbuagu, O., & Ikechukwu-Nwankwo, P. (2023). Attitude of senior secondary school students towards the study of chemistry for sustainable technological development in Owerri Municapal Council Area, Imo State. *Alvana Journal of Sciences (AJS),14* (2): 14-19. ISSN: 1118-5872.

Olatunde-Aiyedun, T. (2024). Artificial intelligence (AI) in education: integration of AI Into science education curriculum in Nigerian Universities. *International Journal for Artificial Intelligence for Digital, 1*(1): 1-14, DOI - 10.13140/RG.2.2.31699.76320

Olatunde-Aiyedun, T. G., & Hamma, H. (2023). Impact of artificial intelligence (AI) on lecturers' proficiency levels in MS PowerPoint, Canva and Gamma in Nigeria. *Journal of Humanity and Artificial Intelligence, 2*(8), 1-16.

Swati, S., & Amanpreet, K. (2024). Efficacy of augmented reality in chemistry education. *A concept note. 5*:1894-1897. doi: 10.1109/ic2pct60090.2024.10486355

Wang-Kin, C. (2021). Pedagogy of emerging technologies in chemical education during the era of digitalization and artificial intelligence: *A systematic review. education sciences, 11*(11):709-. doi: 10.3390/EDUCSCI11110709.