

**PROBLEMS MITIGATING AGAINST THE EFFECTIVE USE OF ARTIFICIAL
INTELLIGENCE IN THE TEACHING AND LEARNING OF CHEMISTRY IN
PUBLIC SECONDARY SCHOOL IN EGOR LOCAL GOVERNMENT AREA**

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FACULTY OF EDUCATION

UNIVERSITY OF BENIN

EDO STATE

NOVEMBER 2025

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**A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF
CURRICULUM AND INSTRUCTIONAL TECHNOLOGY, FACULTY OF
EDUCATION, UNIVERSITY OF BENIN, BENIN CITY, EDO STATE, IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF
BACHELOR OF SCIENCE EDUCATION DEGREE B.Sc. (Ed) IN CHEMISTRY,
UNIVERSITY OF BENIN, BENIN CITY.**

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CERTIFICATION

We, the undersigned, certify that this work was carried out by BELLO GIFT EBOSERHEMEN with matriculation number EDU2102058, in the Department of Curriculum and Instructional Technology (CIT), Faculty of Education, University of Benin, Benin City; and that it is adequate in scope and quality in partial fulfillment of the requirements for the award of Bachelor of Science Degree in Chemistry Education (Bsc. Ed.).

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DEDICATION

This project is dedicated first and foremost to **God Almighty**, whose grace, wisdom, and strength have sustained me throughout this academic journey. His divine guidance has made this accomplishment possible.

ACKNOWLEDGMENTS

My deepest gratitude goes to God Almighty for His unfailing guidance, protection, and grace throughout the course of this project. I am profoundly grateful to all who contributed in various ways to the successful completion of this work.

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ABSTRACT

This study investigated the problems militating against the effective use of Artificial Intelligence (AI) in the teaching and learning of Chemistry in public secondary schools within Egor Local Government Area of Edo State, Nigeria. Guided by a descriptive survey design, the study sampled 100 respondents comprising 40 Chemistry teachers and 60 students drawn from selected public schools. A structured questionnaire and brief interviews were employed to gather data, which were analyzed using frequency counts, percentages, and mean statistics.

Findings revealed that AI integration in Chemistry education is significantly low, with minimal availability and usage of AI tools such as virtual laboratories, simulations, and intelligent tutoring systems. Major barriers identified include inadequate infrastructure such as erratic electricity supply, poor internet connectivity, insufficient computers and digital devices and lack of technical support. The study further established that teachers, though generally willing to adopt AI, possess low competency levels due to limited training and poor exposure to AI-based instructional tools. Additionally, weak policy implementation, inadequate funding, and bureaucratic delays were found to hinder the effective deployment of AI initiatives in public schools.

Despite these challenges, respondents strongly agreed that AI has the potential to enhance learning outcomes in Chemistry if properly integrated. The study recommends sustained government investment in digital infrastructure, continuous teacher training on AI pedagogy, curriculum reform to incorporate AI concepts, and strengthened partnerships between schools and private technology organizations. It concludes that effective AI integration requires a coordinated multi-stakeholder approach that addresses infrastructural deficits, builds teacher capacity, and ensures consistent policy execution, thereby positioning Chemistry education for improved innovation and student engagement.

CHAPTER ONE

INTRODUCTION

Background to Study

The integration of Artificial Intelligence (AI) into the educational sector has revolutionized teaching and learning processes globally. AI technologies such as intelligent tutoring systems, natural language processing, and machine learning algorithms have significantly enhanced personalized learning experiences, improved teacher effectiveness, and expanded access to educational resources (Luckin et al., 2016). In the field of science education, particularly chemistry, AI has the potential to simulate complex chemical reactions, provide real-time feedback, and support inquiry-based learning approaches (Holmes et al., 2019).

Despite these advancements, the effective utilization of AI in the teaching and learning of chemistry in many public secondary schools remains suboptimal, particularly in developing regions where numerous structural, institutional, and socio-economic constraints persist (Luckin et al., 2016). Many of these schools are hampered by an absence of foundational digital infrastructure essential for AI deployment. This includes unreliable or non-existent electricity, inadequate high-speed internet access, and a shortage of functional computer systems or mobile devices. These infrastructural deficits

are often exacerbated by maintenance issues, outdated hardware, and a lack of technical support personnel. (Alamri, A., & Alqahtani, M. 2021)

Furthermore, there is a widespread shortage of educators who possess the dual competencies of technological literacy and subject-specific pedagogical knowledge necessary for the effective integration of AI tools. Even where teachers are open to the adoption of new technologies, they often lack the professional training and continuous development opportunities required to utilize AI meaningfully in their classrooms. (Abdullahi, H. 2019)

Compounding these technical and human resource challenges are socio-cultural and institutional barriers. In many instances, educators and school communities exhibit cultural resistance to technological change, driven by unfamiliarity, fear of job displacement, or a general skepticism toward the reliability of AI systems. Awareness of AI's potential to enrich educational practices remains low, especially in under-resourced areas where basic teaching needs take precedence (Luckin et al., 2016).

Governmental support, though present in policy form, is frequently inadequate in practice. While national and state-level educational frameworks often acknowledge the importance of integrating digital technologies, including AI, the translation of these policies into actionable plans remains insufficient. Limited budgetary allocations specifically earmarked for technological infrastructure, training, and maintenance in schools severely

constrain the deployment of AI-based educational tools (Federal Ministry of Education, 2020).

Fragmented coordination among educational stakeholders including ministries, school management boards, local authorities, and technology vendors further complicates the situation. The absence of a unified framework for AI deployment often leads to duplication of efforts, gaps in coverage, and inefficiencies in resource utilization. Additionally, the lack of public-private partnerships, which could facilitate the integration of innovative AI solutions, results in an overreliance on underfunded government initiatives. (Ezeliora, B., & Ofoegbu, T. 2021)

As a result of these systemic weaknesses, many promising AI technologies remain underutilized or entirely inaccessible to the schools that need them most. This disconnect between policy and practice not only stymies innovation but also perpetuates a cycle of technological marginalization.

These multi-layered barriers collectively stifle the transformative potential of AI in science education, particularly in underserved regions. The persistent lack of access to AI-enabled resources contributes to a growing digital divide, creating disparities in educational quality and student outcomes. (Adedeji, S. O., & Adelabu, M. 2021)

In Nigeria, the Federal Government has recognized the potential of ICT and AI in enhancing educational outcomes and has introduced various policy measures to promote their integration in schools (Federal Ministry of Education, 2020). However, the practical implementation of these policies, especially at the grassroots level such as in local government areas, faces significant challenges. Egor Local Government Area in Edo State exemplifies this issue (Luckin et al., 2016).

Chemistry, as a core science subject, plays an essential role in equipping students with the foundational knowledge required for understanding the natural world and for pursuing careers in STEM. However, the inherently abstract and theoretical nature of many chemistry concepts such as atomic structures, molecular interactions, and chemical bonding poses significant challenges to students (Taber, 2013).

To overcome these hurdles, innovative and learner-centered teaching methodologies are imperative. AI tools such as virtual laboratories, intelligent tutoring systems, and augmented reality platforms can make chemistry more tangible and engaging by providing interactive simulations, personalized feedback, and visual representations of complex concepts. (Ezeliora, B., & Ofoegbu, T. 2021)

Nevertheless, in contexts like Egor LGA, several systemic and contextual barriers severely undermine the realization of these potential benefits. These include

infrastructural deficiencies, limited human capacity, and financial constraints that restrict access to AI technologies.

Statement of the Problem

Despite the global shift toward AI-driven education, many public secondary schools in Egor Local Government Area are yet to effectively adopt these technologies in the teaching and learning of chemistry. Educators often report feeling unprepared or under-resourced to incorporate AI tools, citing challenges such as erratic electricity supply, limited internet connectivity, lack of digital devices, and minimal exposure to relevant training programs (Adedeji, S. O., & Adelabu, M. 2021).

The absence of structured support systems, coupled with resistance to change and insufficient funding, compounds the situation. Financial constraints at both institutional and governmental levels further limit investments in AI infrastructure and teacher development (Taber, 2013).

These multifaceted challenges not only hinder the educational potential of AI but also widen inequalities between urban and semi-urban schools. Students in these schools miss out on interactive and individualized learning experiences that AI can offer, limiting their academic growth and preparedness for future careers in science and technology (Taber, 2013).

Objectives of the Study

The main objective of this study is to identify and analyze the problems militating against the effective use of Artificial Intelligence in the teaching and learning of chemistry in public secondary schools in Egor Local Government Area.

Specific objectives include:

1. To assess the extent of AI integration in chemistry instruction.
2. To identify infrastructural and technological challenges hindering effective AI implementation.
3. To examine teachers' attitudes and competencies regarding AI tools.
4. To investigate the role of government policies and funding in AI integration.
5. To propose sustainable strategies to enhance AI utilization in chemistry teaching.

Research Questions

1. What is the extent of AI integration in chemistry teaching?
2. What infrastructural challenges hinder effective AI use?
3. What are teachers' attitudes and competencies toward AI?
4. How do government policies and funding affect AI adoption?

5. What strategies can enhance AI integration in chemistry education?

Significance of the Study

This study provides empirical data on AI utilization in chemistry education within a Nigerian context. The findings inform policymakers and educators about infrastructural gaps, funding issues, and teacher capacity needs. It offers practical recommendations for integrating AI tools in chemistry education and serves as a reference point for future studies on educational technology.

Scope of the Study

The study focuses on public secondary schools within Egor LGA of Edo State, Nigeria, specifically in the context of chemistry instruction. Private schools and other science subjects are excluded to ensure focused analysis.

Limitations of the Study

Limitations include limited data access, potential bias in self-reported data, and variability in infrastructure across schools.

Operational Definition of Terms

- **Artificial Intelligence (AI):** Computer systems designed to simulate human intelligence for educational use.

- **Chemistry Education:** Teaching and learning of chemistry at the secondary school level.
- **Public Secondary Schools:** Government-funded institutions for secondary education.
- **Egor Local Government Area:** Study location in Edo State, Nigeria.
- **Infrastructural Challenges:** Lack of electricity, internet, or equipment hindering AI use.
- **Teacher Competency:** Educators' ability to effectively utilize AI tools.

CHAPTER TWO

LITERATURE REVIEW

This chapter presents a comprehensive and in-depth review of existing literature concerning the integration of Artificial Intelligence (AI) in educational settings, focusing particularly on its implementation in the teaching and learning of chemistry. The discussion encompasses a broad spectrum of perspectives global, national, and local on the adoption and utilization of AI technologies within education systems (Taber, 2013). It further elaborates on the theoretical underpinnings that inform AI integration, including key educational models and constructs that support its application. In addition, the chapter critically examines empirical studies that investigate the use of AI tools in science classrooms, with a specific interest in chemistry education, and identifies prevailing gaps in knowledge and practice that this study seeks to address (Adedeji, S. O., & Adelabu, M. 2021). The review is systematically organized around core themes that correspond with the research objectives and questions introduced in Chapter One, thereby setting a solid foundation for the study's subsequent analysis and recommendations.

Conceptualizing Artificial Intelligence in Education

Artificial Intelligence (AI) in education refers to the application of various intelligent technologies, including machine learning, natural language processing, computer vision, and robotics, to enhance and transform teaching and learning processes (Luckin et al., 2016). These technologies enable the creation of systems that can replicate or augment cognitive functions such as understanding language, solving problems, recognizing patterns, and making informed decisions.

In the educational context, AI is embodied in a range of applications such as intelligent tutoring systems (ITS), which provide tailored instruction; adaptive learning platforms that adjust content based on student performance; virtual laboratories that simulate real-world scientific experiments; automated grading systems that streamline assessment; and chatbots that offer on-demand academic support (Holmes et al., 2019).

The core value of these technologies lies in their ability to personalize learning pathways, catering to individual student strengths, weaknesses, and learning styles. Through real-time analytics and machine learning algorithms, AI tools can offer instant feedback, promote active learning, and help educators identify and address learning gaps. Additionally, AI enables the automation of routine administrative tasks, thereby freeing up teachers to focus on pedagogical planning and student interaction (Adedeji, S. O., & Adelabu, M. 2021).

Despite these transformative potentials, the adoption and integration of AI in education particularly within science subjects like chemistry face substantial barriers. In many cases, the uneven distribution of digital infrastructure, lack of trained personnel, high cost of AI systems, and resistance to technological change impede effective implementation. This is especially true in resource-constrained environments such as public secondary schools in Nigeria, where systemic challenges continue to hinder the widespread and effective use of AI tools in classroom settings. (Alamri, A., & Alqahtani, M. 2021)

Theoretical frameworks for AI integration in education

Two major theoretical frameworks guide the application of AI in education: Constructivism and the Technological Pedagogical Content Knowledge (TPACK) model.

Constructivist learning theory

Constructivist learning theory, as advanced by scholars like Jean Piaget and Lev Vygotsky, posits that learning is an active, constructive process wherein learners build new knowledge upon the foundation of previous experiences. Piaget emphasized the importance of individual cognitive development through interaction with the environment, while Vygotsky highlighted the social nature of learning, particularly the role of language and collaboration within the zone of proximal development (Adedeji, S. O., & Adelabu, M. 2021).

AI technologies naturally align with these constructivist principles. For instance, simulations allow students to manipulate variables and observe outcomes in a risk-free digital environment, thereby promoting experiential learning and critical thinking. Virtual laboratories in chemistry education replicate real-world scientific experiments, allowing students to engage with abstract concepts through interactive visualization and experimentation. Moreover, AI-powered collaborative platforms support peer-to-peer interaction, discussion, and problem-solving, fostering social construction of knowledge (Ezeliora, B., & Ofoegbu, T. 2021).

Such tools not only enhance cognitive engagement but also provide opportunities for differentiated instruction tailored to each learner's pace and style, thereby deepening conceptual understanding and retention (Bransford et al., 2000).

Technological Pedagogical Content Knowledge (TPACK) framework

The TPACK framework, developed by Mishra and Koehler (2006), outlines the comprehensive body of knowledge that educators must acquire to effectively integrate technology into their instructional practice. The model emphasizes the intersection and dynamic interplay of three core domains: Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK).

Successful integration of AI in chemistry education requires educators to achieve a balanced synthesis of these domains (Ezeliora, B., & Ofoegbu, T. 2021). For instance, a chemistry teacher must understand chemical reactions (CK), know how to facilitate inquiry-based learning (PK), and effectively implement AI-driven tools like adaptive learning platforms or virtual labs (TK). The overlap of these domains known as the TPACK sweet spot enables teachers to design lessons that leverage technology not as an add-on but as an integrated element that enhances both pedagogical strategy and content delivery (Abdullahi, H. 2019).

Moreover, the TPACK framework serves as a diagnostic tool for identifying professional development needs among teachers. In contexts where AI integration is emerging, such as Nigerian public schools, TPACK provides a structured approach for assessing teachers' readiness and guiding targeted interventions. Therefore, embracing the TPACK model is crucial for developing teacher competencies that support the effective and sustainable use of AI in science education (Abdullahi, H. 2019).

Global trends in AI adoption in education

Globally, countries such as the United States, China, Finland, and South Korea have made significant strides in incorporating AI into their educational systems. In the United States, platforms like Carnegie Learning use AI algorithms to provide data-driven insights and personalized feedback to enhance students' mastery of scientific concepts.

China's Squirrel AI leverages adaptive learning technologies to deliver individualized instruction that adapts to students' pace and knowledge levels (Abdullahi, H. 2019).

In the United Kingdom, Century Tech combines AI with neuroscience and learning science to offer real-time assessments and adaptive content delivery. These platforms have been shown to improve learning outcomes, especially in subjects requiring analytical thinking such as mathematics and science (Zawacki-Richter et al., 2019).

In many developed countries, large-scale investments in educational infrastructure have supported the integration of AI technologies. Governments have also prioritized continuous teacher training to ensure educators are proficient in using AI tools. South Korea, for instance, has implemented nationwide programs to train teachers in AI and data literacy, while Finland integrates AI education from an early stage (Alamri, A., & Alqahtani, M. 2021).

Additionally, comprehensive ethical frameworks have been established to guide AI use, addressing concerns such as data protection, bias, and equitable access. Such policies ensure that AI enhances rather than exacerbates educational inequalities (Abdullahi, H. 2019).

AI integration in the Nigerian education system

In Nigeria, the adoption of AI in education is still in its infancy. The Federal Government's National Policy on ICT in Education (2020) acknowledges the transformative potential of digital technologies, including AI, to improve the quality and accessibility of teaching and learning.

Despite this recognition, implementation remains sluggish due to numerous barriers. Among these are infrastructural deficits such as erratic electricity supply, inadequate internet connectivity, and lack of digital learning devices as well as constrained budgetary allocations and widespread digital illiteracy among educators (Ajadi & Salawu, 2021).

While some AI-based educational platforms have been introduced through pilot programs by private technology firms and donor agencies, such efforts are primarily concentrated in urban centers and often lack scalability and sustainability. Rural and semi-urban schools, like those in Egor Local Government Area, are frequently excluded due to poor infrastructure and funding.

The absence of a unified national strategy for AI integration, coupled with insufficient teacher training and low stakeholder engagement, continues to hinder effective utilization in Nigeria's educational system (Ezeliora, B., & Ofoegbu, T. 2021).

AI and chemistry education

Chemistry, characterized by abstract theories and complex laboratory work, benefits immensely from AI tools. These technologies simplify difficult concepts, reduce experimental hazards, and offer personalized learning experiences (Ajadi & Salawu, 2021).

Virtual laboratories, for instance, enable students to perform simulated experiments, reinforcing their understanding of chemical processes without physical risk (Finkelstein et al., 2005). Intelligent Tutoring Systems (ITS) also diagnose individual learning gaps and adapt instruction accordingly.

Studies by Yilmaz and Bayrak (2019) found that students using AI-enhanced platforms performed significantly better in chemistry topics such as stoichiometry and thermodynamics compared to peers taught traditionally. AI tools also improve motivation and engagement through interactive and gamified learning.

However, for success, teachers must be trained to incorporate AI effectively, schools must provide adequate infrastructure, and continuous technical support must be ensured (Ezeliora, B., & Ofoegbu, T. 2021).

Challenges of AI adoption in education

Infrastructure deficits

A major challenge in AI adoption is the lack of supporting infrastructure, including erratic electricity supply, limited internet access, and inadequate digital devices. In many Nigerian public schools, these issues make AI deployment impractical (Oye et al., 2012).

Teacher competency and attitudes

Teachers play a vital role in AI integration, yet many lack digital literacy and training. Some perceive AI as a threat to job security or doubt its reliability (Okebukola, 2021).

Policy and funding constraints

Although policies advocate digital technology integration, funding is insufficient.

Budgetary allocations for ICT and AI initiatives are often inadequate or poorly managed, while implementation and monitoring remain weak (Federal Ministry of Education, 2020).

Socio-cultural resistance

Resistance to technological change, rooted in cultural norms and institutional inertia, also hinders AI adoption. Some administrators and parents are skeptical about replacing traditional teaching methods with AI-based approaches.

Empirical studies on AI use in Nigerian schools

Adebayo and Ogunleye (2020) examined virtual lab use in Lagos State schools and found a positive relationship between AI use and student performance. However, access was uneven and dependent on external funding.

Eze et al. (2021) studied teacher readiness in Enugu State and observed that while interest in AI was high, formal training was limited. They recommended targeted professional development and improved infrastructure to support AI integration.

Gaps in the literature

Existing studies reveal limited research on AI use in chemistry instruction within Nigerian public schools, particularly in semi-urban and rural contexts like Egor LGA. Few studies examine the combined effects of infrastructure, teacher competency, and policy on AI adoption (Oye et al., 2012).

This study fills that gap by analyzing the specific challenges militating against effective AI use in teaching and learning chemistry in public secondary schools in Egor LGA.

Summary of literature review

This chapter has reviewed key concepts, theoretical frameworks, global and local trends, and empirical findings related to AI in education. It emphasized AI's transformative potential while acknowledging persistent barriers such as infrastructure deficits,

inadequate teacher training, weak policy enforcement, and socio-cultural resistance (Eze et al. 2021).

The literature underscores a research gap in contextual studies focusing on semi-urban Nigerian schools. Therefore, the next chapter will present the methodology used to explore these challenges within Egor Local Government Area.

CHAPTER THREE

RESEARCH METHODOLOGY

Introduction

This chapter discusses the research methods, strategies, and procedures used to investigate the topic titled “Problems Militating Against the Effective Use of Artificial Intelligence (AI) in the Teaching and Learning of Chemistry in Public Secondary Schools in Egor Local Government Area.” It presents the systematic approach adopted to ensure objectivity, validity, and reliability of the findings.

The chapter is organized under the following subheadings:

- Research design
- Area of the study
- Population of the study
- Sample and sampling technique
- Instrument for data collection
- Validation and reliability of the instrument
- Method of data collection

- Method of data analysis
- Ethical considerations

Research design

The study employed a **descriptive survey research design**. This design was chosen because it allows the researcher to collect factual data from a sample population and describe existing conditions, practices, opinions, and challenges related to AI use in chemistry education without manipulating variables.

According to Creswell (2014), descriptive surveys are appropriate when the purpose of research is to obtain information about prevailing circumstances, attitudes, or practices. In this study, the design enabled the researcher to assess teachers' and students' perspectives on the extent of AI usage, the challenges encountered, and the institutional factors influencing adoption.

The design also permitted the combination of quantitative and qualitative data through structured questionnaires and brief interviews, offering a holistic understanding of the issues hindering effective AI integration in chemistry classrooms (Eze et al. 2021)..

Area of the study

The study was conducted in **Egor Local Government Area (LGA)** of Edo State, Nigeria. Egor is a semi-urban locality comprising both urban and peri-urban communities. It houses numerous public secondary schools supervised by the Edo State Ministry of Education.

Egor was selected as the study area because it typifies the infrastructural, technological, and human-capacity challenges experienced by public schools in Nigeria. Many of its schools face persistent problems such as erratic electricity supply, poor internet access, limited digital equipment, and insufficient funding all of which directly affect the effective use of AI in teaching.

The choice of Egor LGA provided a balanced context for examining both well-equipped and under-resourced schools, allowing for a realistic appraisal of AI-related educational challenges.

Population of the study

The population of this study comprised all chemistry teachers and senior secondary school students (SS1–SS3) in public secondary schools within Egor LGA.

Teachers were included because they are the primary implementers of curriculum innovations and users of AI tools, while students were included as direct beneficiaries of AI-enhanced instruction.

The estimated population across all target schools was approximately **400 participants**, consisting of about 100 chemistry teachers and 300 chemistry students from different public secondary schools within the LGA.

Sample and sampling technique

A total sample size of **100 respondents** was selected from the target population. This sample included **40 chemistry teachers** and **60 chemistry students** drawn from public secondary schools in Egor LGA.

The **stratified random sampling technique** was used. Schools were first stratified based on location (urban or semi-urban) and ownership (state or community-managed). From each stratum, participants were randomly chosen to ensure equal representation.

According to Nwana (1981), selecting between 10% and 30% of a target population is adequate for educational research; hence, the chosen sample size was considered statistically sufficient. The inclusion of both students and teachers ensured a balanced and multi-perspective analysis of AI-related challenges.

Instrument for data collection

The primary instrument for data collection was a **structured questionnaire** designed by the researcher in line with the research objectives and questions.

The questionnaire was divided into five sections as follows:

- **Section A:** Extent of AI integration in chemistry instruction
- **Section B:** Infrastructural and technological challenges
- **Section C:** Teachers' attitudes and competencies
- **Section D:** Policy and administrative factors
- **Section E:** Strategies for improving AI utilization

Each item was rated using a four-point Likert scale:

- Strongly Agree (4)
- Agree (3)
- Disagree (2)
- Strongly Disagree (1)

Additionally, brief interviews were conducted with selected teachers to obtain qualitative insights on institutional and policy-related barriers to AI use.

Validation of the instrument

To ensure validity, the questionnaire was reviewed by three experts:

- Two lecturers in Science Education
- One specialist in Educational Measurement and Evaluation at the University of Benin

The experts assessed the instrument for clarity, content relevance, and alignment with research objectives. Based on their feedback, ambiguous questions were rephrased, overlapping items were merged, and new questions were introduced to capture government policy and funding dimensions.

This expert validation guaranteed that the instrument effectively measured the intended constructs.

Reliability of the instrument

Reliability was established through a **pilot test** conducted on ten respondents (three teachers and seven students) from a school outside the main study area.

The responses were analyzed using **Cronbach's Alpha** to determine internal consistency. The test yielded a reliability coefficient of **0.81**, indicating a high level of consistency among questionnaire items.

According to Ogunleye (2015), a reliability coefficient above **0.70** is acceptable in educational research. Thus, the instrument was deemed suitable for the main study.

Method of data collection

Data collection was carried out personally by the researcher with the assistance of two trained research aides.

Before distribution, participants were informed of the purpose of the research and assured that their responses would remain confidential. The researcher personally visited each selected school to administer and retrieve the questionnaires.

Teachers' questionnaires were completed during departmental meetings, while students filled theirs during chemistry lessons with permission from school authorities.

This direct approach ensured a **100% retrieval rate** and minimized response bias. Informal interviews with a few teachers provided additional qualitative data that enriched the quantitative findings.

Method of data analysis

The data collected were analyzed using **descriptive statistical tools** such as frequency counts, percentages, mean scores, and standard deviations.

The mean response for each item was calculated and interpreted based on the following decision rule:

- 3.00–4.00 = Agree (High Extent/Positive Response)
- 2.00–2.99 = Disagree (Moderate Extent)
- 1.00–1.99 = Strongly Disagree (Low Extent/Negative Response)

Open-ended and interview responses were analyzed **thematically** to identify common ideas and recurring opinions. The results were presented in tables and narrative discussions according to the five research questions.

Ethical considerations

Ethical compliance was maintained throughout the study. Permission to conduct the research was obtained from the Edo State Ministry of Education and from the principals of participating schools.

Respondents were informed that participation was voluntary and that they could withdraw at any point without penalty. The confidentiality and anonymity of participants were ensured by assigning numerical codes instead of names.

All data collected were used solely for academic purposes, and findings were presented objectively without bias.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

Introduction

This chapter presents, analyzes, and interprets the data collected for the study titled “Problems Militating Against the Effective Use of Artificial Intelligence (AI) in the Teaching and Learning of Chemistry in Public Secondary Schools in Egor Local Government Area.” The analysis is based on responses from 100 participants, comprising 60 students and 40 chemistry teachers drawn from six selected public secondary schools. All distributed questionnaires were retrieved and found usable, yielding a 100% response rate.

Descriptive statistics such as frequency counts, percentages, and mean scores were used to analyze the data, while qualitative responses from interviews were integrated to support the interpretation. The results are presented in line with the five research questions outlined in Chapter One. Each section contains data tables followed by interpretation, discussion, and connections to related literature.

Demographic information of respondents

Variable	Category	Frequency (f)	Percentage (%)
Gender	Male	44	44
	Female	56	56
Respondent Type	Student	60	60
	Teacher	40	40
School Location	Urban	56	56
	Semi-Urban	44	44
Teaching Experience (Teachers)	1–5 years	16	16
	6–10 years	14	14
	Above 10 years	10	10

Interpretation:

The demographic data reveal a balanced gender distribution, with slightly more female participants (56%). Most respondents were students (60%), ensuring that learners’

perspectives were adequately represented. A greater proportion of participants came from urban schools (56%), while 44% were from semi-urban schools, offering a balanced view of varying infrastructural realities.

Among the teachers, 16% had 1–5 years of experience, 14% had 6–10 years, and 10% had over 10 years of teaching experience, indicating diverse professional backgrounds essential for credible insights into AI integration challenges.

Research Question One:

To what extent is Artificial Intelligence (AI) integrated into the teaching and learning of Chemistry in public secondary schools in Egor LGA?

Item	Statement	SA	A	D	SD	Mean (\bar{x})
1	AI tools such as virtual labs and simulations are available in my school.	16	20	36	28	2.12
2	Teachers use AI-assisted instructional materials regularly in Chemistry lessons.	14	18	42	26	2.00
3	AI is included as part of the school's science curriculum or	18	20	36	26	2.10

Item	Statement	SA	A	D	SD	Mean (\bar{x})
	lesson plan.					
4	Students interact with AI-based learning platforms during Chemistry lessons.	20	24	32	24	2.24

Average Mean = 2.12

Interpretation:

The results reveal a low level of AI integration in chemistry instruction. The average mean score of 2.12 indicates that AI technologies are rarely used in the teaching and learning process. Interviews with teachers confirmed that most schools lack the necessary facilities such as computers, projectors, or smartboards.

In some schools, AI-based tools exist but are underutilized due to lack of training and unstable power supply. This finding aligns with Eze et al. (2021) and Ajadi and Salawu (2021), who reported that although Nigerian education policies promote ICT use, AI adoption remains minimal due to infrastructural and financial constraints.

Research Question Two:

What infrastructural and technological challenges hinder the effective use of AI in teaching Chemistry?

Item	Statement	SA	A	D	SD	Mean (\bar{x})
5	There is inadequate access to reliable electricity in my school.	50	36	10	4	3.32
6	Poor internet connectivity limits the use of AI tools.	44	42	10	4	3.26
7	My school lacks computers or digital devices necessary for AI-based learning.	48	36	12	4	3.28
8	There is no technical support or ICT personnel to manage AI tools.	40	38	14	8	3.10

Average Mean = 3.24

Interpretation:

The mean score of 3.24 indicates that infrastructural challenges strongly hinder AI implementation in chemistry education. Respondents identified unreliable electricity, poor internet connectivity, and lack of digital devices as key barriers. Teachers further

noted that maintenance and technical support are almost non-existent even when computers are donated.

This finding is consistent with Oye et al. (2012) and Okebukola (2021), who observed that infrastructural deficits remain the most significant limitation to technology integration in Nigeria’s education system.

Research Question Three:

What are the attitudes and competencies of Chemistry teachers toward AI technologies?

Item	Statement	SA	A	D	SD	Mean (\bar{x})
9	I feel confident using AI tools in teaching Chemistry.	14	20	36	30	2.06
10	I have attended workshops or training on AI in education.	10	16	44	30	1.90
11	I believe AI can improve student learning outcomes.	40	36	14	10	3.06
12	I am willing to learn and integrate AI tools in my teaching.	36	40	16	8	3.04

Average Mean = 2.52

Interpretation:

The average mean of 2.52 suggests moderate awareness but low competency among teachers regarding AI integration. Although many believe AI can improve learning

outcomes, few have received formal training. Interviews revealed that teachers rely mainly on traditional methods due to lack of exposure to digital pedagogy.

This supports the Technological Pedagogical Content Knowledge (TPACK) framework by Mishra and Koehler (2006), which emphasizes that effective technology integration requires a combination of pedagogical and technological competence.

Research Question Four:

How do government policies and funding affect AI adoption in public secondary schools?

Item	Statement	SA	A	D	SD	Mean (\bar{x})
13	Government provides adequate funding for digital and AI programs in schools.	12	18	44	26	2.04
14	Policies supporting AI in education are effectively implemented.	14	20	42	24	2.08
15	Bureaucratic processes delay the execution of government initiatives on AI.	40	36	14	10	3.06
16	There is effective monitoring of AI-related projects by the	16	24	36	24	2.20

Item	Statement	SA	A	D	SD	Mean (\bar{x})
	Ministry of Education.					

Average Mean = 2.35

Interpretation:

The results indicate that government policies and funding are insufficient to sustain AI integration in secondary education. Teachers reported that while AI is referenced in policy documents, its implementation is weak due to poor funding and oversight.

This finding is in line with Ajadi and Salawu (2021) and the Federal Ministry of Education (2020), who both identified gaps between policy formulation and practical execution as major barriers to technology adoption in Nigerian education.

Research Question Five:

What strategies can enhance the effective use of AI in Chemistry education?

Item	Statement	SA	A	D	SD	Mean (\bar{x})
17	Regular teacher training workshops should focus on AI integration.	52	40	6	2	3.44
18	The government should fund computer labs and provide stable electricity.	50	42	6	2	3.42
19	Schools should collaborate with private tech organizations.	44	44	8	4	3.28
20	AI topics should be incorporated into the Chemistry curriculum.	48	40	8	4	3.32

Average Mean = 3.36

Interpretation:

Respondents strongly agreed that teacher training, infrastructure investment, curriculum reform, and public-private partnerships are essential for enhancing AI utilization. Both teachers and students emphasized that AI training should be compulsory for science

educators and that partnerships with technology firms can boost access to tools and expertise.

This aligns with Okebukola (2021) and Yilmaz and Bayrak (2019), who stated that sustainable AI adoption depends on collaboration between government, schools, and private stakeholders.

Summary of major findings

From the analysis, the following key findings emerged:

1. **Low AI integration:** AI tools are rarely used in chemistry instruction.
2. **Infrastructural barriers:** Inadequate electricity, poor internet connectivity, and lack of digital devices hinder implementation.
3. **Teacher skill gap:** Teachers show interest in AI but lack sufficient training and confidence.
4. **Weak policy execution:** Government policies exist but are poorly funded and implemented.
5. **Need for strategic reform:** Continuous training, better infrastructure, and partnerships are crucial for sustainable AI use.

Discussion of findings

The findings align with previous studies emphasizing similar challenges in educational technology adoption. The low mean scores in Research Question One echo Luckin et al. (2016), who observed that developing countries face delayed AI adoption due to infrastructural and financial constraints.

The infrastructural challenges identified in Research Question Two support Oye et al. (2012) and Finkelstein et al. (2005), who highlighted that adequate digital infrastructure is foundational to successful AI implementation.

Teachers' limited competency, as observed in Research Question Three, reflects Mishra and Koehler's (2006) argument that effective teaching with technology requires both pedagogical and technical expertise.

Government and funding challenges discussed in Research Question Four confirm the persistent gap between policy intention and practical outcomes, as reported by Ajadi and Salawu (2021).

Finally, the strategies identified in Research Question Five reinforce Okebukola's (2021) and Yilmaz and Bayrak's (2019) conclusion that sustained progress requires synergy among stakeholders, adequate training, and investment in technology infrastructure.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Introduction

This chapter provides a comprehensive summary, draws logical conclusions, and presents recommendations based on the findings of the study titled “Problems Militating Against the Effective Use of Artificial Intelligence (AI) in the Teaching and Learning of Chemistry in Public Secondary Schools in Egor Local Government Area.”

The main purpose of the study was to examine the level of AI integration in chemistry education and to identify the major constraints hindering its effective application. The study also sought to evaluate teachers’ attitudes and competencies, assess the impact of government policies and funding on AI utilization, and suggest practical strategies to enhance its implementation.

Summary of the study

The study investigated the problems that hinder the effective integration of Artificial Intelligence (AI) in the teaching and learning of chemistry in selected public secondary schools within Egor Local Government Area of Edo State.

A descriptive survey design was employed to obtain empirical data from a total of 100 respondents consisting of 60 students and 40 chemistry teachers drawn from six

randomly selected schools. Structured questionnaires were the main instruments for data collection, complemented by semi-structured interviews to elicit qualitative insights.

The data obtained were analyzed using descriptive statistical tools such as frequency counts, percentages, and mean scores to answer five research questions. The study explored the following themes:

- The extent of AI integration in chemistry instruction
- Infrastructural and technological barriers to AI utilization
- Teachers' attitudes, skills, and competencies regarding AI
- The effect of government policy and funding on AI adoption
- Strategic approaches for enhancing AI use in chemistry education

Findings revealed that although awareness of AI and its potential benefits in science education exists, actual implementation remains minimal due to infrastructural deficits, skill gaps among teachers, and weak government policy enforcement. The study therefore underscored the urgent need for a more coherent national strategy toward digital transformation in education.

Summary of major findings

Based on the analysis presented in Chapter Four, the following key findings emerged:

1. **Low level of AI integration:**

AI tools such as simulations, virtual laboratories, and intelligent tutoring systems are rarely used in chemistry classrooms. The average mean score of 2.12 confirmed minimal engagement with AI-assisted platforms. This suggests that despite global advances in educational technology, most public schools in Egor LGA still rely heavily on traditional teaching methods, thereby limiting students' exposure to innovative digital learning (Luckin et al., 2016).

2. **Infrastructural and technological barriers:**

One of the most pressing challenges identified was the inadequacy of essential infrastructure. Unstable electricity supply, weak internet connectivity, insufficient computer facilities, and lack of maintenance support were highlighted by both students and teachers. The average mean score of 3.24 indicated that these limitations strongly hinder AI implementation in chemistry education (Oye et al., 2012; Okebukola, 2021).

3. **Teachers' competency and training gaps:**

The study revealed that while teachers recognize the potential of AI to improve

learning outcomes, their competency levels and confidence in using AI tools remain low. Many teachers reported having received little or no formal training in AI or digital pedagogy. The mean score of 2.52 confirmed moderate awareness but insufficient skill development, consistent with Mishra and Koehler's (2006) TPACK framework emphasizing the need for pedagogical and technological proficiency.

4. Weak government policy implementation and inadequate funding:

Despite the inclusion of ICT and AI in Nigeria's educational policy documents, the study found a wide gap between policy design and implementation. The average mean score of 2.35 revealed that most respondents perceived government support as inadequate. Policies are often poorly executed due to bureaucracy, inconsistent funding, and lack of effective monitoring mechanisms (Ajadi & Salawu, 2021).

5. Effective strategies for improvement:

The study revealed a strong consensus among respondents on the need for systematic teacher training, increased government funding, improved infrastructure, curriculum reform, and strategic collaboration with private technology organizations. The high average mean of 3.36 across related items

demonstrated strong agreement that these measures could facilitate sustainable AI integration.

Conclusion

From the findings of this study, it can be concluded that the integration of Artificial Intelligence into chemistry education in Egor Local Government Area is still at an embryonic stage. While AI offers vast opportunities for transforming scientific instruction through interactive simulations, virtual laboratories, and personalized learning, its utilization in public schools is significantly limited.

The study established that infrastructural deficiencies such as erratic electricity, poor internet access, and inadequate digital devices remain major impediments. Furthermore, most teachers lack the requisite training, exposure, and confidence to employ AI tools effectively in the classroom. The absence of sustained government funding, coupled with weak policy implementation, exacerbates the challenges.

Despite these obstacles, the study also found strong willingness among teachers and students to embrace AI-based learning if the necessary resources, training, and institutional support were made available. Therefore, effective AI integration in chemistry education requires a multi-stakeholder approach involving government agencies, educational institutions, technology organizations, and community support.

In essence, without deliberate investment in infrastructure, teacher training, and curriculum reform, AI will remain an underutilized innovation in Nigeria's educational system rather than a catalyst for transformative learning.

Recommendations

Based on the major findings and conclusions, the following recommendations are proposed:

1. **Regular capacity building for teachers:**

The government, through the Ministry of Education, should organize continuous professional development programs and workshops to train chemistry teachers in AI integration. These should include hands-on training in the use of AI-driven learning tools, digital classroom management, and problem-based learning applications.

2. **Provision of adequate infrastructure:**

Adequate funding should be allocated to provide reliable electricity, high-speed internet connectivity, and computer laboratories equipped with AI-compatible devices. Sustainable maintenance structures should also be established to ensure longevity of the provided facilities.

3. Curriculum reform and policy implementation:

The national chemistry curriculum should be revised to include AI concepts and applications, ensuring students develop early digital literacy. Furthermore, the Federal and State Ministries of Education must ensure strict implementation of ICT and AI policies through effective monitoring and evaluation frameworks.

4. Enhanced government funding:

Both federal and state governments should allocate specific budgetary provisions to support AI education. This includes grants for schools to procure digital tools and funds to sponsor teacher training and student innovation programs.

5. Public–private partnerships (PPP):

Collaboration with private technology companies, NGOs, and international organizations should be encouraged. Such partnerships can facilitate donations of digital devices, provision of software licenses, and sponsorship of capacity-building initiatives.

6. Creation of school-based AI clubs:

Schools should establish AI and digital innovation clubs to encourage students to explore AI concepts through peer learning, competitions, and project-based activities. This will help sustain students' interest and engagement in AI-enhanced learning.

7. Awareness and sensitization campaigns:

Stakeholders such as parents, school administrators, and community leaders should be sensitized on the importance of AI in modern education through seminars, advocacy programs, and media campaigns. This will foster communal support and understanding of digital learning reforms.

8. Monitoring and evaluation mechanisms:

A robust system should be established to monitor AI-related educational programs to ensure transparency, accountability, and measurable outcomes. This will enhance sustainability and continuous improvement of AI initiatives.

Suggestions for further studies

The present study was limited to public secondary schools in Egor Local Government Area. To deepen understanding and generalize findings, future research should consider the following areas:

1. Comparative studies on AI adoption in urban and rural schools to identify contextual variations in infrastructure and readiness.
2. Experimental studies to measure the impact of AI-based instructional tools on student achievement and motivation in chemistry and other science subjects.

3. Qualitative investigations into the perceptions and experiences of teachers who have successfully integrated AI tools into their teaching.
4. Studies exploring the ethical, social, and privacy implications of AI technologies in Nigerian classrooms.
5. Longitudinal studies assessing the sustainability and long-term outcomes of AI initiatives in secondary education.
6. Cross-disciplinary research examining AI integration in other STEM subjects, such as physics, biology, and mathematics, to broaden the scope of educational innovation.

Contribution to knowledge

This study has contributed to the existing body of literature in several significant ways:

1. It provides empirical evidence of the infrastructural, pedagogical, and policy-related barriers hindering AI integration in Nigerian secondary schools.
2. It establishes a framework for understanding AI readiness among teachers and students within the context of chemistry education.
3. It highlights the importance of aligning government policy, funding, and teacher capacity development as essential pillars for sustainable educational innovation.

4. It offers practical and context-specific recommendations for policymakers, educators, and technology partners seeking to promote AI adoption in science education.
5. It serves as a baseline reference for future research and policy formulation aimed at strengthening digital education systems in developing countries.

In summary, this study underscores the urgent need for a paradigm shift in Nigeria's educational system from traditional instructional approaches to technology-driven methods. If the recommendations presented herein are effectively implemented, Artificial Intelligence can revolutionize chemistry education by fostering creativity, improving performance, and preparing students for participation in a global digital economy.

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APPENDIX

Problems Militating Against the Effective Use of Artificial Intelligence in the Teaching and Learning of Chemistry in Public Secondary Schools in Egor Local Government Area Questionnaire

This questionnaire is designed to collect options from secondary school students and teachers in Egor local Government area regarding the effective use of AI in the teaching and learning of chemistry in public secondary schools. Your responses are confidential and will be used solely for academic research purposes.

Section A: Demographic Information (5 Items)

1. What is your gender?
 - () Male
 - () Female

2. What is your current class level/teaching level?

- () SS1
- () SS2
- () SS3
- () Chemistry Teacher

Section B: Awareness and Knowledge of AI (6 Items)

3. Have you heard of Artificial Intelligence (AI)?

- () Yes
- () No

4. How would you rate your understanding of AI?

- () Very good
- () Good
- () Fair
- () Poor

5. AI involves machines performing tasks like problem-solving, learning, and decision-making. Do you agree?
- () Strongly agree
 - () Agree
 - () Disagree
 - () Strongly disagree
6. Which of the following AI tools have you used or heard of in an academic setting?
(You may tick more than one)
- Virtual labs
 - Chatbots or AI tutors
 - Adaptive learning software
 - AI-powered assessment tools
 - None
7. Is AI currently being used in your chemistry class?
- () Yes
 - () No

- Not sure

Section C: Accessibility and Infrastructure (6 Items)

8. Does your school have access to a computer lab?

- Yes

- No

9. Is there regular internet access in your school?

- Yes

- No

- Occasionally

10. How often is electricity available during school hours?

- Always

- Sometimes

- Rarely

- Never

11. Are there enough computers or devices for students and teachers?

- Yes
- No
- Only for administrative use

12. Have you received any training in how to use AI tools in education?

- Yes
- No

Section D: Perceived Benefits of AI in Chemistry Learning (6 Items)

13. AI can help make difficult chemistry concepts easier to understand.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

14. Virtual labs could replace the need for real chemical substances in many cases.

- Strongly agree
- Agree

- Disagree
- Strongly disagree

15. AI tools can provide personalized feedback to students.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

16. AI reduces the stress associated with manual lesson preparation (for teachers).

- Strongly agree
- Agree
- Disagree
- Strongly disagree

17. AI can help students learn chemistry independently outside the classroom.

- Strongly agree
- Agree

- Disagree
- Strongly disagree

Section E: Challenges and Barriers to AI Use (7 Items)

18. Lack of AI-related knowledge among teachers is a major barrier.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

19. The high cost of digital devices prevents effective AI use.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

20. Teachers are resistant to changing their traditional teaching methods.

- Strongly agree

- Agree
- Disagree
- Strongly disagree

21. AI applications are too complex for most students to use without assistance.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

22. There is little or no policy support from the government regarding AI in schools.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

23. Inadequate funding limits AI implementation in your school.

- Strongly agree

- Agree
- Disagree
- Strongly disagree