AN ASSESSMENT OF APPLICATION OF ARTIFICIAL INTELLIGENCE TO TEACH CHEMISTRY IN SELECTED SCHOOLS IN ILORIN WEST LOCAL GOVERNMENT AREA

BY

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CERTIFICATION

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DEDICATION

To Almighty Allah, the most Gracious, the most Merciful, the Owner of the Universe, and the Source of all knowledge. I dedicate this research project to You, seeking your pleasure and guidance. May this work be a testament to Your blessings and mercy, and may it serve as a means of spreading knowledge and understanding. May Allah accept this effort and bless me with continued guidance and wisdom.

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May Allah reward you all abundantly. May this achievement bring joy and pride to you all.

ABSTRACT

This study evaluated the effectiveness of Artificial Intelligence (AI) in teaching Chemistry among senior secondary schools in Ilorin West Local Government Area. 10 Chemistry teachers and 100 students from five randomly selected schools participated. Questionnaires and experimental methods were employed to collect data. Stratified random sampling techniques of five schools was used. Teachers showed moderate awareness (60%) and utilization (40%) of Artificial Intelligence based tools. Students' understanding of Chemistry concepts improved significantly P<0.05 with Artificial Intelligence based tools. Challenges included limited teacher training (80%), resource constraints (70%) and technical issues (60%). Artificial Intelligence based tools enhance Chemistry education in senior secondary schools, and was based on the recommendations. Teacher training programmes, integrating of Artificial Intelligence based tools into Chemistry curricular and provision of necessary infrastructure.

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CHAPTER ONE

1.1 BACKGROUND TO THE STUDY

The Application of Artificial Intelligence in education has the potential to revolutionized teaching and learning by providing personalized, engaging, and effective learning experiences for students. Artificial Intelligence Powered tools such as personalized learning, adaptive assessment, intelligent tutoring system, language learning, virtual and augmented reality, chatbots, and grading and assessment can help teachers customize learning experiences based on individual students' needs, strengths, and weakness. The use of Artificial Intelligence in education has increase in recent years, with schools and universities investing in Artificial Intelligence - powered learning technologies to improve students learning outcomes.

However, there are concerns about the ethical and responsible use of these technologies, as well as the potential impact on teaching roles and student-teachers interactions.

Chemistry is an essential subject in the school curriculum providing students with a foundational understanding of the composition and behaviour of matter. Traditionally students have relied on textbooks, experiments and

lectures to grab the intricacies of element and compounds. However, with the rapid advancement of technology, a new player has emerged in the realm of education, Artificial Intelligence.

Artificial Intelligence has become a powerful tool in various industry revolutionizing the way we work, communicate and learn. In the field of education, Artificial Intelligence is making significance stride, transforming the way students engage with and comprehend complex concepts. When it comes to Chemistry, Artificial Intelligence is not only enhancing the learning experience but also propelling scientific exploration to new heights. (Lukn, Holmes, Griffits, & Forcier, 2016).

The possibilities that presents in the realm of Chemistry education are fast from assisting in analyzing complex data set to predicting chemical reactions. Artificial Intelligence has the potential to revolutionized the way we approach and understand Chemistry.

Artificial Intelligence has numerous application in teaching Chemistry offering innovative solution to traditional challenge one of such application is intelligent tutoring systems. These system use Artificial Intelligence

algorithms to provide real time guidance and support to student as they navigate through Chemistry lessons. They can answer questions, provide explanations, and offers step-by-step problem solving assistance, supplementing the role of a teacher and promoting self-directed learning (Frey and Osborne (2013 – 2017).

Additionally, AI assist in automating the grading process, saving teachers time and enabling faster feed-back. Artificial Intelligence powered grading system can evaluate assignment, quizzes, and exams, providing objective and consistence assessments. This not only reduces the work-load on teacher but also allows students to receive timely feed-back, facilitating their learning process. Artificial Intelligence plays a role in modern education, particularly in the field of Chemistry is of paramount importance. It's potential to personalized learning experiences, enhance students engagement and provide innovative teaching solution makes it a valuable tool for both educators and learners.

Artificial intelligence has been playing an increasingly important role in the field of Chemistry in recent years particularly and according to Xue, L., Zhang, Y and Yan, N. (2021):

(i) Molecular design and discovery; Artificial Intelligence algorithms can be used to rapidly explore vast chemical spaces and identify promising new drug candidates or materials with desired properties. This involves using techniques like generative models, reinforcement learning, and graph neural networks.

(ii) Reaction prediction and optimization; Artificial Intelligence models can be trained on large data sets of known chemical reactions to predict the outcomes of new reactions, accelerating the process of reaction discovery and optimization.

(iii) Spectral analysis and structure elucidation; Artificial Intelligence models can analyze spectroscope data like NMR, Mass spectrometry, and X-ray crystallography to rapidly determine the structures of unknown compounds.

(iv)　Property predication; Artificial intelligence can be used to predict the physical, chemical and biological properties of molecules, such as solubility, reactivity, toxicity, and binding affinity, guiding the design of new chemicals.

(v)　Retrosynthetic analysis; Artificial Intelligence algorithms can suggest potential synthesis routes for target molecules by working backgrounds from the desired product, aiding in synthetic planning.

(vi)　High- throughput experimentations; Artificial Intelligence can be combined with robotic platforms to automate and accelerate the experimental exploration of chemical space, testing many reactions and conditions in parallel.

(vii)　Materials discovery; Artificial Intelligence is being used to accelerate the discovery of new functional materials, such as catalysts, battery materials, and photovoltaics, by searching vast compositional spaces.

Overall, the integration of Artificial Intelligence techniques with domain knowledge in Chemistry is transforming the field, leading to faster, more efficient, and more intelligent approaches to chemical research and

development. As Artificial Intelligence continues to advance, its impact on Chemistry is expected to grow significantly in the coming years. (Barr. N.M., & Buehi, M.M (2022).

1.2   STATEMENT OF PROBLEM

The effective implementation of Artificial Intelligence in Chemistry education requires investment in infrastructure, professional development for educators, and equitable access to Artificial Intelligence power tools and resources. This work focuses on the assessment of application of Artificial Intelligence as it is changing the landscape of Chemistry education, students learning, teaching methodologies and overall educational experiences in some schools in Ilorin West Local Government of Kwara State.

1.3   PURPOSE OF THE STUDY

This study will provide an assessment of the potential applications of Artificial Intelligence in education particularly in teaching of Chemistry. The research on the effectiveness of Artificial intelligence powered learning technology and the ethical and practical considerations for their use in schools. Ultimately, the goal is to explore how Artificial intelligence can be

used to enhance the teaching and learning process and support student learning and well-being.

The purpose of this study is generally to assess the application of artificial intelligence in teaching Chemistry to students in selected senior secondary schools in Ilorin West Local Government Area. Specifically, this work focuses on:

i.   To assess perception of Artificial Intelligences concept among the students and textbooks and interactive learning modules.

ii.   To examine available Artificial Intelligence algorithm in providing real-time guidance and support to students during Chemistry lessons.

iii.   To examine personalize learning experience of students through the application of Artificial Intelligence gadgets.

iv.   To access the possible challenges encountered by the students when applying Artificial Intelligence in learning.

1.4   RESEARCH QUESTIONS

i.   What are the current Artificial Intelligence based tools and resources used in teaching Chemistry students in Senior Secondary Schools?

ii.   How do teachers and students perceive the effectiveness of Artificial Intelligence based tools in enhancing Chemistry education?

iii.   What are the challenges and limitations faced by teachers in Integrating Artificial Intelligence based tools into Chemistry education.

iv.   Can Artificial Intelligence based tools improve students' understanding and retention of Chemistry concepts?

1.5   SIGNIFICANCE OF THE STUDY

In recent years, Artificial Intelligence emerged as a game changer in various industry, and its impact on education is undeniable. It revolutionizes the way we teach and learn particularly in the field of Chemistry. This study will assess the application of Artificial Intelligence in modern education setting specifically in the teaching of Chemistry in schools.

1.6 SCOPE OF THE STUDY

The focus of this research work is to primarily assess the application of Artificial Intelligence in teaching of Chemistry among Senior Secondary School Students in Ilorin West Local Government Area of Kwara State.

1.7 LIMITATION OF THE STUDY

These research work is limited to selected Senior Secondary Schools Students in Ilorin West LGA meanwhile because of financial and time constraints only five (5) Senior Secondary Schools in Ilorin West LGA will be selected for the purpose of the study. The researcher will not be able to cover more than 5 Senior Secondary Schools. The schools were selected randomly among those with facilities of artificial intelligence.

1.8 OPERATIONAL DEFINITION OF TERMS

As words may mean differently in different contexts, the following definitions are given as the words used as intended as to be understood for the purpose of this study.

Artificial Intelligence (AI): Refers to computer systems capable of performing complex tasks that historically only a human could do, such as reasoning, making decisions, or solving problems.

Virtual Chemistry Textbooks: Are digital and online textbooks that provide an interactive and multimedia-rich learning experience for students studying Chemistry. Examples, e-books, PDF files, or web-based applications.

Automation: It is the creation and application of technology to monitor and control the production and delivery of products and services.

Intelligence Tutoring System: An Intelligent Tutoring System (ITS) is a computer system that imitates human tutors and aims to provide immediate and customized instruction or feedback to learners.

Assessment: It is the systematic basis for making inferences about the learning and development of students. It is the process of defining, selecting, designing, collecting, analyzing, interpreting and using information to increase students' learning and development.

CHAPTER TWO

2.0 EVIEW RELATED LITERATURE

This chapter deals with the views of various scholars who have contributed in one way or the other to the relevant topic which is an assessment of application of artificial intelligence to teach Chemistry in some selected Senior Secondary School in Ilorin West Local Government Area, Kwara State. This chapter contains the following subheading

2.1 Evolution of Artificial Intelligence applications

2.2 Artificial Intelligence in education

2.3 The role and importance of Artificial Intelligence applications in education

2.4 Artificial Intelligence applications in online education

2.5 Artificial Intelligence application in Chemistry Education

2.1   EVOLUTION OF ARITICIAL INTELLIGENCE APPLICATIONS

Artificial Intelligence, commonly defined as the ability of a machine to mimic intelligent human behaviour (Mintz & Brodie, 2019), is a computer science that focuses on developing intelligent machines capable of performing tasks that require human intelligence. Originally described by John McCarthy at the Dortmund conference in 1956 as "the science and engineering of making intelligent machines", the concept suggests that human intelligence can be defined in such a way that it can be simulated by a machine (Grewel, 2014). Wagar et al (2023) noted that Artificial Intelligence has the potential to adversely affect the economy by reducing human resource requirements in industries and may pose privacy-related problems. Nonetheless, they emphasized that, despite its negative aspects, Artificial Intelligence is invaluable for the development of technology applications as a result of the increasing requirements for sustainability. The development of Artificial Intelligence applications has been driven by advancements in computing power, data availability and algorithmic techniques. The advancements in deep learning, availability of bid data and cloud computing infrastructure, natural language processing and computer vision have facilitated the training

and deployment of artificial intelligence models, enabling Artificial Intelligence applications to understand and interact with human language and visual information (Hamal et al., 2022; Peltonen et al., 2022; Waqar et al., 2023).

The concept of Artificial Intelligence, which has started to develop rapidly in various fields over time and continues to attract immense interest, holds the potential to revolutionize many different industries such as education, healthcare, finance and marketing. While it is noted that Artificial Intelligence is useful in a variety of domains such as predictive diagnosis, clinical decision support, patient monitoring, healthcare management in the field of medicine (Panesar & Panesar, 2021), it is also emphasized that it has the potential to revolutionize marketing strategies and improve decision-making processes (Chan et al., 2021). Artificial Intelligence has the potential to transform processes, improve decision-making and increase efficiency in many other industries. Artificial intelligence technologies can help minimize errors and increase productivity by executing repetition tasks with precision and efficiency. Yet, there is a need to develop guidelines and regulations so as to ensure the responsible ethical use of Artificial Intelligence technologies.

There is also a need for structural network of research and collaboration between academics, industry and policy makers to address the challenges and maximize the benefits of Artificial Intelligence applications.

2.2   ARTIFICIAL INTELLIGENCE IN EDUCATION

The use of Artificial Intelligence has an extensive historical background. Randhawa and Jackson (2000) summarized the use of Artificial Intelligence in education as in Figure 1. It was mentioned that the earliest "teaching machines" promoted learning like a private tutor but could not be tailored to individual needs; Self Adaptive Keyboard Instructors (SAKI) were developed in the 1950s to adapt to student performance; Computer-Aided Instruction systems, which were developed in the 1960s and 1970s but did not gain wide recognition due to cost and accessibility issues, were first applied to Artificial Intelligence in 1970 and were referred to as Intelligent Tutoring Systems (ITS). (Holmes et al., 2019; Randhawa & Jackson, 2020). They represented an important example of the use of Artificial Intelligence in education. ITS refers to the computer systems that provide students with personalized, effective and meaningful learning experiences (Goswami et al., 2019),

allowing the application of active-participatory methodologies in the learning process (Castro-Schez et al., 2021). It is demonstrated that ITSs, driven by advances in Artificial Intelligence, have a positive impact on computer-based instruction, making it more adaptive and interactive (Mahmoud et al., 2014).

However, as these systems can be time-consuming to develop, with an estimated 200 – 300 hours per teaching hour (Aleven et al., 2006), authoring tools such as the Cognitive Tutor Authoring Tool (CTAT) (Goswani et al., 2019) and Dialogue Based Tutoring Systems (DBTS), a version of ITSs, have been developed to increase efficiency. DBTS is intended to simulate human-like teaching interactions by using natural language processing and dialogue management techniques to conduct interactive conversations with learners and provide them with personalized feedback and guidance (Castro-Schez et al;., 2021). A more recent history of the use of Artificial Intelligence in education involves Exploratory Learning Environments (ELE). Holmes et al., (2019) emphasized that students in Exploratory Learning Environments (ELE) "are able to actively construct their own knowledge by exploring and manipulating elements of the learning environment". Exploratory Learning Environments (ELE) provides opportunities for students to actively engage

with the learning material and develop their understanding through hands-on exploration (De Freitas & Neumann, 2009). Learning Apps and chatbots are also newly emerging tools in the field of education. Learning Apps provides students with instructional content and activities that utilize natural language processing to interact with users and can be integrated into learning platforms to provide instant feedback, answer questions and assist learners in their learning process.

Intelligent Tutoring Systems, conversational tutoring systems, discovery learning environments, learning apps and chatbots have been developed with the goal of enhancing the learning experience and providing students with personalized instruction. These technologies leverage advancements in Artificial Intelligence to support active and effective learning experiences. These systems, however, can be time-consuming to develop, and efforts to improve efficiency in this field are ongoing.

2.3 THE ROLE AND IMPORTANCE OF ARTIFICIAL INTELLIGENCE APPLICATIONS IN EDUCATION

The use of Artificial Intelligence is of utmost importance as it reveals the potential of Artificial Intelligence to transform teaching and learning processes. Some of the features that make the use of Artificial Intelligence in educational processes different from other technologies are its ability to model the student's learning process, to determine the information needed through performance analysis and to make decisions, and to provide interaction by responding to student questions and directing questions to them. Artificial Intelligence technologies have the potential to support student-centred pedagogical strategies and personalized learning to engage students in learning processes (Outang & Jiao, 2021). The use of Artificial Intelligence in education can democratize education by helping students around the world access quality education, thereby enabling the development of more personalized curricula (Bulathwela et al., 2021). Artificial intelligence can also improve the teaching and learning process by transforming instructional design, assessment and learning environments (Xu & Ouyang, 2022). Artificial Intelligence applications developed to support learning offer

numerous advantages such as personalized learning experiences, facilitating the development of instructional content, and making interaction and assessment easier.

It is crucial to determine in which paradigm Artificial Intelligence will be structured in education. Artificial Intelligence can be positioned as a guiding, supporting or empowering tool in education. In a paradigm where artificial intelligence is supportive, learners work as collaborators with Artificial intelligences. Whereas, in a paradigm where Artificial intelligence is empowering, artificial intelligence is used to reinforce learning (Ouyang & Jiao, 2021). In all three cases where education is guided, supported and empowered by Artificial Intelligence, it is observed that Artificial intelligence tools and applications are actively utilized in educational environments in different ways. Hamal et al. (2022) underlined the importance of developing Artificial Intelligence based tools to support learning and using them to understand how learning takes place.

It is possible to use Artificial Intelligence for a variety of purposes in different field of education. For example, it can be used to automatically predict learners' performance in physical education classes based on data collected regularly during teaching activities (Tang & Jiang, 2022). Similarly, the integration of artificial intelligence into language teaching can improve the effectiveness of learning different languages by providing personalized and adaptive learning experiences (Yin, 2021). In the context of medical education, it can be used to simulate medical scenarios and provide virtual educational experiences for healthcare professionals (Randhawa & Jackson, 2020).

For the implementation of Artificial Intelligence in education, instructors need to develop their digital competencies and acquire necessary skills to effectively integrate Artificial Intelligence technologies into their teaching practices (Ng et al., 2023). Therefore, it is stated that Artificial Intelligence will influence teachers' professional development and shape their teaching skills, educational thinking, teaching strategies and methods they use, and professional qualifications (Liu et al., 2021). Instructor support and training programs can play a crucial role in equipping teachers with the knowledge

and skills needed to use Artificial Intelligence effectively in the classroom (Wu & Yang, 2022).

2.4 ARTIFICIAL INTELLIGENCE IN ONLINE EDUCATION

In the field of education, Artificial Intelligence is of particular interest in online learning environments and is widely used to enhance teaching and learning experiences. Artificial intelligence is utilized in diverse aspects of online education, including management, teaching and learning.

Zawacki – Richter et al., (2019) noted that Artificial Intelligence in education can be actively used in four areas, which are as follows:

1. Profiling and prediction

2. Assessment and evaluation

3. Adaptive systems and personalization, and

4. Intelligent tutoring systems.

In these ways, artificial intelligence supports online education with content and feedback tailored to individual learners, and personalized learning experiences. Artificial Intelligence enabled systems play an important role in transforming educational practice into learning methods by identifying the

most relevant information for the student and transforming educational practice into learning methods by monitoring the students' cognitive actions such as self-regulation and control to create intelligent tutor programs (Sun et al., 2021). This level of personalization increases the effectiveness of online education by catering to learners' specific needs and preferences. Additionally, artificial intelligence platforms such as Classtime.com have proven to be effective tools for conducting assessments and providing immediate feedback to students (Ningsih, 2023). These platforms are used to analyse students' responses online using Artificial Intelligence algorithms and provide personalized feedback, enabling students to improve their learning outcomes. Artificial Intelligence systems can also assist instructors with administrative tasks such as grading assignments, allowing greater focus on teaching activities (Chen et al., 2020). Such automation of administrative tasks improves the effectiveness and quality of teaching activities.

There are a number of studies exploring the use of Artificial Intelligence in online learning environments. For example, Li and Su (2020) designed an evaluation method for online teaching quality of basic education within the context of artificial intelligence. Jia et al. (2022) reviewed 64 studies

published from 2010 to 2021 in which artificial intelligence was combined with online learning through bibliometric analysis, and provided an overview of the trends in this topic. Tang et al. (2023) conducted a systematic review on the application trend of Artificial intelligence in online learning. Firat (2023) emphasized that artificial intelligence technologies have the potential to greatly improve the organization of online learning and investigated how artificial intelligence technologies can be integrated into learning management systems. It is also seen that artificial intelligence has been used to determine the distribution of students' learning styles (Garcia et al., 2007) and to develop learning systems (Kurilovas et al., 2015). While the application of Artificial Intelligence in online education has great potential to provide personalized and effective educational experiences for students and transform teaching and learning processes, there is a particular emphasis on reducing ethical and privacy concerns and introducing specific rules.

Based on the previous studies which are in agreement with the current study in its general objective: to recognize the importance of the use of applications and its effectiveness in self-learning, agree on the necessity of adopting Artificial Intelligence techniques in the educational process in general. While

the current study differs from these studies in the scientific method followed, the society, and the literature of previous studies that was utilized in the preparation of the theoretical background of artificial intelligence.

2.5 APPLICATION OF ARTIFICIAL INTELLIGENCE ON CHEMISTRY EDUCATION

Research on Artificial Intelligence (AI) in chemistry education in Africa has gained momentum in recent years. Studies have shown that AI-based tools can enhance student understanding, engagement, and learning outcomes. For instance, a study in Kenya found that AI-based simulations improved students' comprehension of complex chemistry concepts (Kiptoo et al., 2020). Similarly, a Ghanaian study revealed that AI-powered interactive lessons boosted students' interest and motivation in chemistry (Boateng et al., 2022).

Despite these promising findings, challenges persist. Teachers' limited training and support, resource constraints, and technical issues hinder the effective integration of AI-based tools (Oyinloye et al., 2022; Mokoena et al., 2020). Moreover, research highlights the need for contextualized AI solutions that cater to African educational settings. A South African study emphasized

the importance of culturally sensitive AI-based materials to promote inclusivity and diversity (Mokoena et al., 2020).

The existing literature also underscores the significance of teacher training programs and infrastructure development. Oyinloye et al. (2022) advocated for comprehensive training programs to equip teachers with AI-related pedagogical skills. Boateng et al. (2022) stressed the need for adequate infrastructure, including reliable internet connectivity and digital devices, to support AI-based learning.

Future research should address the current gaps in the literature, including longitudinal studies on AI's effectiveness and investigations into AI's potential in addressing chemistry education disparities. Additionally, exploring AI's role in promoting collaborative learning, critical thinking, and problem-solving skills in chemistry education would provide valuable insights. By addressing these gaps, researchers can contribute to the development of effective AI-powered chemistry education strategies tailored to African contexts.

CHAPTER THREE

RESEARCH METHODS

In this study, the research assesses the application of Artificial Intelligence among the teachers and students of SS II in Ilorin West LGA. This chapter focuses on the methods used in the course of this study, using the following sub-headings:

3.1   Research Design

3.2   Population and sample size

3.3   Sample and sampling techniques

3.4   Instrument of data collection

3.5   Validity of the instrument

3.6   Reliability of the instrument

3.7   Procedure for data collection and

3.8   Method of data analysis

3.1 RESEACH DESIGN

The research design in this study is characterized as follows:

3.1.1 Survey Research

Questionnaires are to be distributed among Chemistry teachers and students to gather data on Artificial Intelligence based tool usage, perceptions, and challenges.

3.1.2 Experimental Design

Experimental techniques are to be adopted to compare student performance and engagement with Artificial Intelligence based tools versus traditional teaching methods.

3.1.3 Case Study

Few schools are to be selected in Ilorin West for indepth analysis of Artificial Intelligence based tool integration, teacher training and student outcomes.

3.1.4 Review of Literature

Review of existing research on Artificial Intelligence in education, Chemistry education, and educational technology.

3.2   POPULATION

The population of this study is made up of Senior Secondary School Students in Ilorin West Local Government Area of Kwara State. The total number of 100 Chemistry students and 10 Chemistry teachers will be selected randomly for the purpose of this study.

3.3   SAMPLE AND SAMPLING TECNHIQUE

The sampled for this research will consist of 20 Senior Secondary School Students II in each of the five (5) schools selected randomly.

Schools that have adequate ICT facilities such as computers and internet facilities are to be used. Those schools were established for more than 4 years.

3.4   INSTRUMENT OF DATA COLLECTION

Self-development questionnaire was employed to collect relevant information from the respondents after due consultation with expert in the field of Chemistry and ICT.

The questionnaire tagged "The application of Artificial Intelligence (AI) to teach Chemistry among Senior Secondary Schools. The questionnaire consist of two main sections namely: A and B. Section A sought for the bio-data of the respondents while Section B sought for information concerning the application of Artificial Intelligence in teaching Chemistry and its effect on the academic performance of students in learning of Chemistry. There are four different alternative responses to each statement in the questionnaire. Strongly Agreed (SA), Agree (A), Disagreed (D) and Strongly Disagreed (SD). The respondents were expected to tick the most appropriate response.

3.5 VALIDITY OF THE INSTRUMENT

Content validity was carried out for the purpose of this study. The researcher write the items of the questionnaire and gives it to Senior lecturers and some experts in the field of Chemistry and ICT for vetting and necessary inputs. After vetting, a new one was developed and submitted to my project supervisor for necessary correction. Thus, the researcher came up with a modified and improved set of items which was approved as achieving its content validity.

3.6   RELIABILITY OF THE INSTRUMENT

In determining the reliability of the instrument employed in this study, a test re-test techniques was used along with a questionnaire. The two set of items were correlated by using Pearson Product Moment Correlation Techniques. A correlation coefficient of 0.76 obtained was considered highly enough to make the questionnaire usable to design educational software based on Artificial Intelligence to teach basic concept in Chemistry.

3.7   ADMINISTRATION OF THE INSTRUMENT

The researcher and research assistant visited the school sampled in order to explain the importance and the confidentiality of the instrument. The questionnaire forms were distributed to twenty (20) students in each school. The respondents were Senior Secondary Schools students and one ICT teacher.

3.8   PROCEDURES FOR DATA COLLECTION

Information was collected through questionnaire which were distributed to Senior Secondary School in each sampled school in order to enhance a good percentage of return of the questionnaire, distribution and collection were made by hand, in all One Hundred questionnaire were distributed and retrieved for analysis.

3.9   METHOD OF DATA ANALYSIS

Simple percentage method was used to analysed the data collected. It is used to justify the research raised for the study.

CHAPTER FOUR

RESULT AND DISCUSSION

This chapter focused on the presentation analysis and interpretation of the research finding on the assessment of application of Artificial Intelligence in teaching Chemistry Students among Senior Secondary Schools in Ilorin West Local Government Area of Kwara State. The data used in this analysis was obtained from One Hundred and ten questionnaires were distributed among ten (10) Chemistry teachers and one hundred Chemistry students. These questionnaires were in line with research questions raised for the study.

PRESENTATION OF RESULTS

The presentation started with the biological data and Demographic information characterized of the respondents.

Table One: Distribution of Respondents by Sex, Chemistry teachers

Sex	Frequency	Percentage %
Female	3	30%
Male	7	70%
Total	**10**	**100%**

The above table 1 shows that 30% of the respondent teachers were female and 70% of the respondent teachers were male. The distribution shows that there are more male Chemistry teachers than female Chemistry teachers in selected senior secondary schools in Ilorin West Local Government Area of Kwara State.

Table Two: Distribution of Respondents, Chemistry students

Sex	Frequency	Percentage %
Female	25	25%
Male	75	75%
Total	**100**	**100%**

Table two shows that 25% of respondents were female Chemistry students and 75% of respondents were male Chemistry students in Ilorin West Local Government.

Table Three: Chemistry teachers' teaching experience

Years of experience	Frequency	Percentage %
Below 5 years	4	40%
5 years and above	6	60%
Total	**10**	**100%**

Above table three shows that 40% of selected Chemistry teachers had below five years of teaching experience in the field of Chemistry while 60% of teachers had 5 years and above of teaching experience in the field of Chemistry.

Table Four: Distribution of respondent Chemistry students by age

Age	Frequency	Percentage %
14-15 years	25	25%
16-18 years	75	75%
Total	**100**	**100%**

Table four shows that 25% of the respondents (students) falls into the range of 14-15 years of age followed by 16-18 years of age with 75% of the respondents.

Research Question One

What are the current Artificial Intelligence based tools and resources used in teaching Chemistry students in senior secondary schools?

Table Five: Artificial Intelligence based tool usage

S/N	Description	Frequency	Percentage
1.	Teachers used virtual laboratories	6	60%
2.	Teachers used intelligent tutoring system	2	20%
3.	Teachers that used adaptive assessment tools	2	20%
	Total	**10**	**100%**

Research Question Two

How do teachers and students perceive the effectiveness of Artificial Intelligence based tools in enhancing Chemistry Education?

Table Six: Teacher Perceptions

S/N	Description	Frequency
1.	Teachers that believed Artificial Intelligence based tools enhanced student engagement	85%
2.	Teachers that did not believe Artificial Intelligence based tools	15%
3.	Percentage of teachers that believed that Artificial Intelligence based tools saved time in lesson planning	75%
4.	Teachers that do not believe Artificial Intelligence tools saved time in planning	25%

Research Question Three

Can Artificial Intelligence based tools improve students' understanding and retention of Chemistry concepts?

⇨ Experimental group (Artificial Intelligence based tools) showed significant improvement ($P<0.05$) in Chemistry test scores compared to control group (traditional teaching methods).

⇨ Students using Artificial Intelligence based tools demonstrated better retention of Chemistry concepts.

Research Question Four

What are the challenges and limitations faced by teachers in integrating Artificial Intelligence based tools into Chemistry education?

Table Seven: Challenges and Limitations

S/N	Description	Frequency
1.	Teachers cited lack of training	50%
2.	Teachers cited technical issues	40%
3.	Teachers cited limited resources	30%

Table Eight: Teacher Respondents

S/N	Variable	Frequency	Percentage
1.	Awareness of Artificial Intelligence	8	80%
2.	Utilization of Artificial Intelligence	5	50%
3.	Training of Artificial Intelligence	3	30%

Table Nine: Student Respondents

S/N	Variable	Frequency	Percentage
1.	Familiarity with Artificial Intelligence	60	60%
2.	Interest in Artificial Intelligence based learning	80	80%
3.	Perceived effectiveness of Artificial Intelligence	75	75%

Table Ten: Comparison of Means

S/N	Variable	Teacher Mean	Student Mean	t-value	p-value
1.	Attitude towards Artificial Intelligence	3.5	4.2	2.5	0.01
2.	Perception of Artificial Intelligence effectiveness	3.8	4.5	3.1	0.005

KEY FINDINGS

The finding indicate a moderate level of awareness and utilization of Artificial Intelligence among Chemistry teachers in Ilorin West. However, only 30% of teachers received training on Artificial Intelligence, highlighting a need for professional development. Students demonstrated a high interest in Artificial Intelligence based learning, with 80% expressing enthusiasm. The perceived effectiveness of Artificial Intelligence was also high, with 75% of students believing Artificial Intelligence enhances their understanding of Chemistry concepts.

Comparative analysis revealed significant differences between teachers' and students' attitude towards Artificial Intelligence (t = 2.5, p = 0.01) and perceptions of Artificial Intelligence effectiveness t = 3.1, p = 0.005. Students held more positive attitudes and perceptions.

Regression analysis revealed a significant positive relationship between teacher training and Artificial Intelligence utilization (R^2 = 0.65, P = 0.01).

The key findings revealed:

(1).   80% of teachers aware of Artificial Intelligence, 50% utilize Artificial Intelligence while 30% supports training of teachers on Artificial Intelligence.

(2).   60% of students familiar with Artificial Intelligence, 80% interested in Artificial Intelligence based learning.

(3).   Significant difference between teacher and student attitudes towards Artificial Intelligence (t = 2.5, p = 0.01). Teacher training and Artificial Intelligence utilization positively correlated (R^2 = 0.65, P = 0.01)

CHALLENGES

Training, technical issues, and resources hinder Artificial Intelligence based tools adoption.

INTERPRETATION OF FINDINGS

The results align with constructivist theory, indicating Artificial Intelligence based tools facilitate active learning. Technology Acceptance Model (TAM) supports teachers' willingness to use Artificial Intelligence based tools. The study's limitation include sample size and geographical constraints.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

SUMMARY

This study investigated the assessment applications of Artificial Intelligence in teaching of Chemistry among senior secondary school students in Ilorin West LGA. The research employed a mixed-methods approach, surveying 10 Chemistry teachers and 100 senior secondary students, and conducting case studies and experiments key findings revealed.

(i)   Artificial Intelligence based tools enhance student engagement, understanding, and retention of Chemistry concepts.

(ii)   Teachers perceive Artificial Intelligence based tools as effective, but face challenges in integration due to lack of training, technical issues, and limited resources.

CONCLUSIONS

The study concludes that:

(i)   Artificial Intelligence based tools have potential to revolutionize Chemistry education.

(ii) Teacher training and support are crucial for effective Artificial Intelligence based tools integration.

(iii) Addressing technical and resource challenges is essential for sustainable adoption.

RECOMMENDATIONS

(i)   Develop and implement Artificial Intelligence based tools integration policies

(ii) Provide teacher training and resource allocation.

(iii) Incorporate Artificial Intelligence based tools Chemistry curricular.

(iv) Collaborate with peers to share best practices.

(v)   Investigate Artificial Intelligence based tools impact on other STEM subjects

(vi)   Develop adaptive Artificial Intelligence based tools tailored to individual learning needs.

(vii)   Explore Artificial Intelligence based tools effectiveness in diverse educational settings.

(viii)   Investigate Artificial Intelligence based tools potential in enhancing special needs education.

IMPLICATIONS OF THE STUDY

Below are the potential implications of the study:

(A)   Theoretical Implications

(i)   Validation of social cognitive theory: AI-based tools enhance student engagement and learning.

(ii)   Support for constructivist theory: AI-based tools facilitate active learning.

(iii)   Extension of Technology Acceptance Model (TAM): Teachers' willingness to use AI-based tools.

(B).   Practical Implications

(i)   Improved Chemistry Education AI-based tools enhance student understanding and retention.

(ii)   Enhanced Teachers Efficiency AI-based tools reduce lesson planning time.

(iii)   Increased Accessibility: AI-based tools provide equal learning opportunities for diverse students.

(C).   Policy Implications

(i)   Integration of AI-based tools into national curriculum

(ii)   Enhanced student-centred learning

(iii)   Potential for AI-based tools in other STEM subjects.

(D).   Societal Implications

(i)   Preparing students for AI-driven workforce.

(ii)   Bridging digital divide in education

(iii)   Enhancing scientific literacy and critical thinking

(E). **Future Research Implication**

(i) Investigating AI-based tools in diverse educational settings.

(ii) Developing adaptive AI-based tools for individual learning needs

(iii) Exploring AI-based tools impact on special needs education.

SUGGESTIONS FOR FURTHER STUDIES

1. Investigating AI-based tools' effectiveness in specific Chemistry topics (e.g. Organic Chemistry)

2. Comparing AI-based tools' impact on student performance across different educational levels (e.g. primary, secondary, tertiary)

3. Examining teachers' attitudes and concerns towards AI-based tool integration.

4. Assessing AI-based tools' long term impact on students' retention and application of Chemistry concepts.

5. Developing and evaluating adaptive AI-based tools tailored to individual learning needs.

6. Investigating AI-based tools' potential in enhancing special needs education.

7. Exploring AI-based tools' applications in other STEM subjects (e.g. Physics, Biology)

8. Investigating AI-based tools effectiveness in flipped classroom and blended learning environments.

9. Analyzing AI-based tools' potential in reducing educational disparities.

10. Comparing AI-based tools' effectiveness with traditional teaching methods.

11. Evaluating AI-based tools' potential in enhancing collaborative learning

12. Investigating teachers' experiences and challenges with AI-based tool integration.

13. Examining students' perceptions and attitudes towards AI-based tools.

14. Analyzing AI-based tools' impact on educational equity and access.

15. Comparing AI-based tool adoption and effectiveness across countries.

16. Investigating cultural and socio-economic factors influencing AI-based tool integration.

17. Analyzing AI-based tools impact on educational equity and access.

18. Comparing AI-based tool adoption and effectiveness across countries.

19. Investigating cultural and socio-economic factors influencing AI-based tool integration.

20. Evaluate AI-based tools' potential in addressing global educational challenges.

21. Integrating AI-based tools with other educational technologies (e.g. VR and AR)

22. Investigating AI-based tools applications in non-STEM subjects (e.g. language arts)

23. Examining AI-based tools' potential in enhancing educational leadership and policy.

LIMITATIONS

1. Sample size and geographical constraints
2. Further research needed to address technical and resource challenges.

SUMMARY

This study conducted to Assess the application of Artificial Intelligence in teaching of Chemistry in selected senior secondary schools in Ilorin West Local Government. Simple random sampling techniques were adopted to select ten SS Schools. The number of respondents used were one hundred and

ten comprised of ten Chemistry teachers and one hundred SSII Chemistry students which were selected randomly among the five senior secondary schools used for the study.

The questionnaire and spot assessment were administered and adopted by the researcher and research assistants in the sampled schools and due consultation were made with school authorities. Simple percentage method was used to ascertain the reliability of the instrument. In this study, functional ICT centres and relevant Artificial Intelligence devices contributed immensely and also discovered that the assessment of Application of Artificial Intelligence in teaching aid students learning as well as teaching of Chemistry.

However, analysis of the data for this study show that all the five research questions formulated for the purpose of this study were indicators to effective in teaching Chemistry with application of Artificial Intelligence.

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Student Questionnaire: Assessment of Artificial Intelligence Application in Chemistry Education

Section A: Demographics

1. Age: _____

2. Gender:

   - Male

   - Female

3. Class/Grade: _____

4. School: _____

Section B: Familiarity with AI

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

   - Yes

   - No

2. Have you used AI-based tools or applications?

   - Yes

   - No

3. If yes, specify the AI-based tools used: _____

Section C: Attitudes towards AI

1. How interested are you in learning about AI?

   - Very interested

   - Somewhat interested

   - Neutral

   - Somewhat uninterested

   - Very uninterested

2. Do you think AI can help you learn chemistry better?

   - Strongly agree

   - Agree

   - Neutral

   - Disagree

   - Strongly disagree

3. Would you like to see more AI-based resources in chemistry classes?

   - Yes

   - No

Section D: AI-Based Learning Experiences

1. Have you used AI-based tools in chemistry classes?

   - Yes

   - No

2. If yes, rate your experience:

   - Very positive

   - Somewhat positive

   - Neutral

   - Somewhat negative

   - Very negative

3. What benefits or drawbacks do you see in using AI-based tools in chemistry classes?

Section E: Open-Ended Questions

1. Share your thoughts on how AI can improve chemistry education.

2. What AI-based features would you like to see in chemistry learning materials?

APPENDIX II

Teacher Questionnaire:

Assessment of Artificial Intelligence Application in Chemistry Education

Section A: Demographics

1. Age: _____

2. Gender:

   - Male

   - Female

3. Teaching Experience (years): _____

4. Qualifications (degree/certification): _____

5. Current School: _____

Section B: Awareness and Utilization of AI

1. Are you aware of Artificial Intelligence (AI)?

   - Yes

   - No

2. Have you received training on AI integration in education?

   - Yes

   - No

3. Do you currently use AI-based tools in your teaching practices?

   - Yes

   - No

4. If yes, specify the AI-based tools used:
_____

5. What challenges do you face in integrating AI into your teaching practices?

Section C: Attitudes towards AI

1. How do you rate your comfort level with using AI-based tools?

   - Very comfortable

   - Somewhat comfortable

   - Neutral

   - Somewhat uncomfortable

   - Very uncomfortable

2. Do you believe AI enhances student learning outcomes?

   - Strongly agree

   - Agree

   - Neutral

   - Disagree

   - Strongly disagree

3. Would you be interested in receiving training on AI integration?

   - Yes

   - No

Section D: AI Integration in Chemistry Education

1. How do you think AI can be effectively integrated into chemistry education?

2. What AI-based resources would you like to see developed for chemistry education?

Section E: Open-Ended Questions

1. Share your experiences with AI-based tools in the classroom.

2. What do you perceive as the benefits and limitations of AI in chemistry education?