ZAMFARA INTERNATIONAL JOURNAL OF SCIENCE TECHNOLOGY EDUCATIONAND MATHEMATICS (ZIJSTEM) Volume 3, Number 1, March, 2026

ZAMFARA INTERNATIONAL JOURNAL OF SCIENCE TECHNOLOGY EDUCATION AND MATHEMATICS (ZIJSTEM)

ISSN: 2251-0974

Volume 3, Number 1, March, 2026

https://doi.org/10.64348/zije.2026369

The Official Journal of The Department of Science Education Federal University Gusau, Zamfara State

www.foefugusau.com.ng

des@fugusau.edu.ng

PUBLISHED BY:
Department of Science Education
Federal University Gusau Zamfara State, Nigeria.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026368

ZAMFARA INTERNATIONAL JOURNAL OF SCIENCE TECHNOLOGY EDUCATION AND MATHEMATICS (ZIJSTEM)

A PUBLICATION OF THE DEPARTMENT OF SCIENCE EDUCATION, FEDERAL UNIVERSITY GUSAU, ZAMFARA STATE, NIGERIA

ISSN: 2251-0974

VOLUME THREE 3, NUMBER 1, MARCH, 2026

INDEXED IN:
OpenAIRE
The Official Indexing Partner of the European Commission (EU),
Google Scholar

https://doi.org/10.64348/zije.2026369

Website: foefugusau.com.ng
E-mail: des@fugusau.edu.ng

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026368

COPYRIGHT:
Department of Science Education, Faculty of Education, Federal University Gusau, Zamfara State, Nigeria

DISCLAIMER:
Every Author is solely responsible for the views and styles expressed in the articles published in this journal. The views are not necessarily shared by reviewers, the Editorial Advisory Board, the Department of Science Education, Federal University Gusau, Zamfara State, Nigeria

OPEN ACCESS STATEMENT:
This publication is licensed under the Creative Commons Attribution 4.0 International (CC BY 4.0). This is an open access journal which means that all content is freely available without charge to the user or his/her institution. Users are allowed to read, download, copy, distribute, print, search, or link to the full texts of the articles, or use them for any other lawful purpose, without asking prior permission from the publisher or the Author. However, Authors retain copyright and full publication rights.

REPOSITORY POLICY
Authors are free to deposit their papers in all versions including submitted, accepted and published version in any institutional or other repository of their choice without embargo from the ZIJSTEM. Thus, published source must be acknowledged with citation.

PUBLISHED BY:
Department of Science Education, Faculty of Education, Federal University Gusau, Zamfara State, Nigeria.

TECHNICAL SUPPORT BY:
Teknize Innovative Digital Solutions, Ahmadu Bello University, Zaria, Kaduna State, Nigeria. www.teknize.com

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026368

EDITORIAL BOARD MEMBERS

Editor-In-Chief/chairman Editorial Board	***Professor Bashir Suleiman*** Mathematics Education
Associate Editor/Head, Science Education Department	***Dr. Nuhu Ishaq Lawal*** Vocational & Technical Education
Editor/Dean, Faculty of Education	***Dr. Umar Sodangi*** Mathematics Education
Editor	***Professor Amos Shaibu*** Chemistry Education
Editor	***Professor M. M. Atadoga*** Physics Education
Editor	***Professor A. K. Tukur*** Educational Technology
Editor	***Professor C. Dikki*** Physical & Health Education
Publication Editor	***Dr. Yakubu A. Abdullahi*** Chemistry Education
Editor	***Dr. Akilu Ismail*** Biology Education
Editor	***Dr. Ganiyu Adedo*** Chemistry Education
Editor	***Dr. Halima Yahaya*** Biology Education
Secretary, Editorial Board	***Adamu Ibrahim*** Mathematics Education

CONSULTING EDITORS

Professor A. S. Haruna	Maryam Abacha American University of Nigeria, Kano State
Professor J. S. Marie	Ahmadu Bello University, Zaria, Kaduna State
Professor Dantani I. Wushishi	Federal University of Technology, Minna
Professor Rabi Muhammad	Usmanu Danfodiyo University, Sokoto
Professor Babawuro Shuaibu	Abubakar Tafawa Balewa University, Bauchi
Professor A. K. Tukur	Usmanu Danfodiyo University, Sokoto
Professor A. I. Gambari	Federal University of Technology, Minna
Professor Amos Shaibu	Ahmadu Bello University, Zaria, Kaduna State
Professor M. A. Yushau	Abubakar Tafawa Balewa University, Bauchi
Professor M. M. Atadoga	Ahmadu Bello University, Zaria, Kaduna State
Professor Caleb Bolaji	Ahmadu Bello University, Zaria, Kaduna State

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026368

EDITORIAL NOTE

Zamfara International Journal of Science Technology Education and Mathematics (ZIJTEM) is the official Journal of the Department of Science Education, Faculty of Education Federal University Gusau Zamfara State, Nigeria. The Journal publishes articles of diverse fields of interest in Sciences, Technology, Education and Mathematics. Papers reporting original research and extended version of already established conference and journal articles are welcomed. Papers for publication are selected through peer review process to ensure originality, relevance and readability. ZIJSTEM is published quarterly which spans throughout the year i.e. March, June, September and December, respectively.

The aim and scope of the journal is to provide an academic medium and an important reference for the advancement and dissemination of information that supports high level learning, teaching and research in the fields of Sciences, Technology, Education and Mathematics.

The articles in this volume are academic and professional discourse written by reputable scholars in their area of specialization.

Professor Bashir Suleiman
Editor-in-Chief/ Chairman Editorial Board

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026368

FORWARD

On Behalf of the staff and students of the Department of Science Education, Federal University Gusau, Zamfara state, Nigeria, we humbly acknowledge and thank Allah (S.W.T) the most beneficent, the most merciful for without his will, collection and computation of this journal publication would not have been possible. May all praise be ascribed unto Him. The department is sincerely grateful to its accommodating mentor Prof. Tukur Adamu, Vice Chancellor, Federal University, Gusau and his management team for giving the department enabling environment for academic activities. The department's profound gratitude goes to Dr. Umar Sodangi who doubled as the Dean, Faculty of Education, Federal University, Gusau and Associate Editor of Zamfara International Journal of Science, Technology, Education and Mathematics (ZIJSTEM). Furthermore, Special gratitude goes to our contract and visiting Professors, the staff and students of the Department of Science Education, Federal University, Gusau, for their supports and foresight towards actualizing the dream of the department.

The Zamfara International Journal of Science, Technology, Education and Mathematics (ZIJSTEM) is a brain child of Department of Science Education with the aim of bringing science and technology education into global and well recognized journals of science and technology education research. This is first of its kind, among Science Education Departmental Journals in Northwest, Nigeria and by extension one of the highly placed departmental journals in Nigeria, considering its online visibility and originality, based on well-known global best practices.

Dr. Nuhu Ishaq Lawal
Associate Editor/Head of Department,
Science Education, Faculty of Education,
Federal University, Gusau

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026368

CALL FOR ARTICLES

The Zamfara International Journal of Science, Technology, Education and Mathematics (ZIJSTEM) calls for scholarly articles for review and possible publication in its next edition (Volume 3, Number 2, June, 2026), ZIJSTEM publishes articles that emphasizes on research development and application within the field of Sciences, Technology, Education and Mathematics. All manuscripts are reviewed by editorial review committee. Contributions must be original, not previously or simultaneously published elsewhere, and are critically reviewed before they are published. Papers, which must be written in English language, should have good grammar and proper terminologies.

PLAGIARISM POLICY

ZIJSTEM is committed to maintain high standards through an in-depth peer review process with sound ethical policies. Any infringements of professional ethical codes, such as plagiarism; including self-plagiarism, fraudulent use of data are seriously frowned at by the journal with zero tolerance.

ZIJSTEM implements the code of conduct of Committee on Publication Ethics (COPE), and uses the COPE flowcharts for resolving cases of suspected plagiarism or any publication misconduct. Hence, prospective articles are subjected to plagiarism assessment test to estimate the percentage of originality of the papers. Hence, Plagiarism threshold of $\leq$20% is recommended.

In order to avoid plagiarism cases with ZIJSTEM, the following guidelines must be strictly adhered to by the Authors;

1. Authors should ensure that they have written entirely original works, and if Authors have used the work and/or words of others then, this has to be appropriately cited or quoted.
2. An Author should not, in general, publish manuscripts describing essentially the same research in more than one journal or primary publication. Submitting the same manuscripts to more than one journal concurrently constitutes unethical publishing behavior and is unacceptable.
3. Proper acknowledgement of the work of others must always be adhered to. Authors should cite publication that have been influential in determining the nature of the reported work

EDITORIAL GUIDELINES

1. Manuscripts including references, appendices, tables and diagrams should be double-spaced and single coded on A4 paper with generous margins (at least ½.5cm).
2. Title should be explicit and not more than 19 words.
3. Title page should be arranged as follows: Title, Author (s) full name, affiliation, full addresses, email addresses and phone numbers.
4. Abstract should be single line and not more than 250 words.
5. For conceptual papers, the body should have appropriate headings were necessary
6. For empirical papers, it should be presented in the following order; Introduction, Objectives of the study, Research questions and/or Hypothesis, Methodology, Results, Discussion of Findings, Conclusion and Recommendations.
7. Acknowledgement (if any)
8. Quotations of more than 40 words should be indented and typed single spacing with indication of the pages where the quotes were lifted
9. In-text citations should follow APA 7th edition format
10. References should be in range with 7th edition of APA style
11. Each table and figures should be presented within the manuscripts, with a brief and self-explanatory title

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026368

12. All text within the table should be clearly eligible, and all graphics and legends should be easily distinguished when printed in black and white
13. Tables should be in in horizontal line only, with only blank space to separate column
14. Tables and figures that may be included in the main text of the paper should be numbered separately, in the sequence that they are mentioned in the text.
15. Figures should be saved in a neutral data format such as JPEG, TIFF OR EPS.

SUBMISSION OF MANUSCRIPTS & ASSESSMENT FEE

Manuscripts for Volume 3. Number 2, with an evidence of a non-refundable assessment fee of five thousand Naira (N5000:00) only per manuscript should be forwarded electronically to the Editor-In-Chief or Publication Editor via; **des@fugusau.edu.ng** on or before June 14, 2026. Furthermore, upon acceptance of manuscript for publication a non-refundable publication fee of Thiry thousand naira (N30,000:00) will be required for online version per manuscripts. Furthermore, a comprehensive e-book will be made available.

Dr. Yakubu A. Abdullahi
Publication Editor
abdullahiyakub@fugusau.edu.ng
07065699399

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026368

TABLE OF CONTENTS

S/N	Authors, Paper Title and DOI Index	Pages
1	**NWEZE, Vitalis Onyekachi., MOHAMMAD, Ibrahim & HAMMA, Robert Arab (2026):** Quality Early Childhood Education: A Panacea for fostering Social Unity and Reduces the Menace of Insecurity Security in Nigeria https://doi.org/10.64348/zije.2026339	1-9
2	**UMAR, Nafisa Muhammad., HASSAN, Muhammad Nasiru & TAMBUWAL, Nasiru I. (2026):** Effect of Differentiated Instruction on Motivation in Mathematics Concepts among Senior Secondary School Students in Malumfashi Education Zone of Katsina State, Nigeria https://doi.org/10.64348/zije.2026340	10-18
3	**NAJIB, Abdullahi (2026):** Evaluation of Validity and Reliability of Pre-Service Geography Teachers' Grit Questionnaire among Colleges of Education in Northwest, Nigeria https://doi.org/10.64348/zije.2026341	19-27
4	**OKHAWERE, Paulson Young Ofenimu (2026):** Comparative Analysis of Workplace Productivity: An Insights from Maslow's Hierarchy of Needs, Herzberg's Two-Factor Theory and Self Determination Theory https://doi.org/10.64348/zije.2026342	28-35
5	**ISHAKU, Ruth (2026):** Assessment of Water Sanitation and Hygiene Practice Among Citizens in Mubi North Local Government Area of Adamawa State, Nigeria https://doi.org/10.64348/zije.2026343	36-44
6	**USMAN, Opeyemi Lateef., ADEUSI, Oluwasegun Opeoluwa., KAREEM, Morufat Adebola., OWOADE, Akeem Ayoade & MUNIYANDI, Ravie Chandren (2026):** Qualitative Study on Impact of EfficientNet-Based Deep Transfer Learning Model for Pneumonia Detection with Explainable Artificial Intelligence using Chest Radiographs https://doi.org/10.64348/zije.2026344	45-56
7	**IKWUJE, Andrew Ikwuje (2026):** Assessment of Entrepreneurial Skills Acquisition among Upper Basic Science Students in Apa Local Government Area of Benue State, Nigeria https://doi.org/10.64348/zije.2026345	57-64
8	**ILAH, Hafsat Garba., SHAMSUDEEN, Bello & USMAN, Galadima (2026):** Effects of Assignment Activities on Attitude and Self-Efficacy in Biological Drawings among Secondary School Students in Sokoto State, Nigeria https://doi.org/10.64348/zije.2026346	65-71
9	**DAJAL, R. G. & AWOYEYE, Agnes O. (2026):** Effects of Think–Pair–Share Instructional Strategy on Interest and Achievement in Ecology Concept among Secondary School Biology Students in Federal Capital Territory, Abuja, Nigeria https://doi.org/10.64348/zije.2026347	72-79
10	**DANALAMI, Kazaik Benjamin., SANI, Shitu Mohammed & SAID, Jamilu Abdulrahman (2026):** Effect of Differentiated Instruction on Motivation in Mathematics Concepts among Senior Secondary	80-92

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026368

	School Students in Malumfashi Education Zone of Katsina State, Nigeria https://doi.org/10.64348/zije.2026348	
11	**SALMAN, Medinat F., YAHAYA, L. A., ADEDOKUN-SHITTU, Nafisat A., BELLO, Muhinat B., OLAITAN, O. L., DOMINIC, Olufunmilola L., OGUNJIMI, M. O., BOLU-STEVE, Foluke., ATOLAGBE, A. A., ABDULLAHI, M. S. & ALABI, Hafsat (2026):** Development and Utilization of Interactive Digital Manual for Academic Engagement and Assessment in General Studies among Undergraduate Students in University of Ilorin, Kwara State, Nigeria https://doi.org/10.64348/zije.2026349	**93-102**
12	**BASSEY, Edwin Okpa (2026):** Comparative Assessment of WhatsApp and Facebook Social Media Applications Utilization on School Adjustment among Undergraduate Students in Cross River State, Nigeria https://doi.org/10.64348/zije.2026350	**103-115**
13	**USMAN, Aisha Abdulrahman., SHAMSUDDEN, Bello & AHMAD, Hadiza Gusau (2026):** Effect of In-Class Flipped Classroom Model on Academic Performance in Practical Biology Concepts among Secondary School Students in Kebbi State, Nigeria https://doi.org/10.64348/zije.2026351	**116-125**
14	**OMAGWU, Ameh., NUHU, Ishaq Lawal., BABALOLA, Victor T. & OBEDA, Godwin (2026):** Assessment of Teachers Preparedness and Challenges on Integration of Artificial-Intelligence Tools for Basic-Science Teaching among Universal-Basic-Education Schools in Kaduna State, Nigeria https://doi.org/10.64348/zije.2026352	**126-136**
15	**MUSA, Hauwa Rabiu., ISAH, Aishat Yakubu & OLAITAN, Aisha Salau (2026):** Evaluation of Artificial Intelligence Tools Integration among Pre- Service Biology Teachers: A Case Study of Federal University of Education, Zaria, Kaduna State, Nigeria https://doi.org/10.64348/zije.2026353	**137-143**
16	**DALHATU, Mohammed Nuraddeen (2026):** Effect of Rehabilitation Counselling Intervention on Academic Adjustment among Learners with Special Needs in Mainstream Secondary Schools in Zaria, Kaduna State, Nigeria https://doi.org/10.64348/zije.2026354	**144-151**
17	**ADEBAYO, Mutalib (2026):** Qualitative Study of E-Learning Tools Utilization on Productivity Level among Extension Agents in Nigeria: A Systematic Approach https://doi.org/10.64348/zije.2026355	**152-159**
18	**NZOGBU, Ugochukwu I., TSENKWO, Joseph B. & GOSHIT, Gideon G. (2026):** Assessment of Deposit Money Banks Credit, Banking Sector Depth and Economic Growth in Nigeria: An Econometric Investigation 1987-2024 https://doi.org/10.64348/zije.2026356	**160-169**
19	**OKORONKA, Ugwumba Augustine & FWANGLE, Ishaya Istifanus (2026):** Correlation Between Reach and Endurance Adversity Intelligence Quotients on Achievement in Physics among Secondary School Students in North-Central, Plateau State, Nigeria https://doi.org/10.64348/zije.2026357	**170-182**

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026368

20	**AUDU, Samson., GIMBA, Ramatu W & ABDULRAHMAN, Muhammad Alfa (2026):** Effects of Jigsaw and Numbered-Head-Together Instructional Strategies on Achievement and Retention in Algebraic Concept among Secondary School Students in Minna Metropolis, Niger State, Nigeria https://doi.org/10.64348/zije.2026358	183-193
21	**ALI, Zakiya Baba., SAFIYANU, Lawal Yusuf., MAHBOUB, Khadija., WADA, Shamsiya., BASHIR, Ibrahim & GWARZO, Auwal Sani (2026):** Correlation Between Weaning Practices and Severe Acute Malnutrition on Child Health among Care-Givers attending Aminu Kano Teaching Hospital, Kano State, Nigeria https://doi.org/10.64348/zije.2026359	194-200
22	**DANGANA, Badamasi Mohamed., ABUBAKAR, Hauwa Umaru., Mohammed, Abel Ali & KAMAL, Ahmad Mu'az (2026):** Effects of Virtual and Guided Discovery Instructional Strategies on Academic Achievement in Biology Concepts among Secondary School Students in Adamawa State, Nigeria https://doi.org/10.64348/zije.2026360	201-210
23	**BALOGUN, Sikirat Adenike & AWOBODU, Victoria Yetunde (2026):** Correlation Between Gender and School Factors on Achievement in Basic Science among Students in Ojo Local Government Area of Lagos State, Nigeria https://doi.org/10.64348/zije.2026361	211-220
24	**BAKINDE, Surajudeen., FATOBA, O. J., SANGODEYI, Oluwatosin A. & IGBA, I. E. (2026):** Correlation Between Physical Activity Level and Health Status of Undergraduate Students in University of Ilorin, Kwara State, Nigeria https://doi.org/10.64348/zije.2026362	221-227
25	**GAYUS, Wankwalamda., MOHAMMED, Abel Ali., SHUAIBU, A. & NAYE, n. e. (2026):** Effects of Analogy and Guided Inquiry Instructional Strategies on Academic Achievement and Interest in Biology Concepts among Secondary School Students in Adamawa State, Nigeria https://doi.org/10.64348/zije.2026363	228-236
26	**YUSUF, Abdulkabir Toriola., YAKUBU, Safiya., ISIAQ, Abdulmuhit Temitope & ALI, Babangida (2026):** Effect of Reproductive Health Education Intervention Programme on Risky Sexual Behaviours Among Undergraduate Female Students in North-West, Nigeria https://doi.org/10.64348/zije.2026364	237-248
27	**MOHAMMED, Aishetu & BAWA, Sa'adatu Mohammed (2026):** Qualitative Study on Level of Poverty in Africa in the 21st Century: Causes, Challenges and Way Forwards https://doi.org/10.64348/zije.2026365	249-256
28	**MUSAH, Ibrahim., ISA, Ahmed-Sherif., ALHASSAN, Abdulwahab., EMMANUEL, Nachamada Sinclair., DOGARA, Kabir Jibril & UMAR, Zainab (2026):** Differential Amelioration of Aminoglycoside-Induced Oxidative Stress by Virgin Coconut Oil in the	257-265

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026368

	Vestibulocochlear Tissue and Serum of Wistar Rats https://doi.org/10.64348/zije.2026366	
29	**OSAGIE, Eguagie (2026):** Correlation Between Stress and Job Commitment among Public University Non-Teaching Staff in Edo State, Nigeria. https://doi.org/10.64348/zije.2026367	**266-274**

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026339

Quality Early Childhood Education: A Panacea for fostering Social Unity and Reduces the Menace of Insecurity Security in Nigeria

NWEZE, Vitalis Onyekachi[1]
Email Address: nezevitalis2011@gmail.com;
Phone Number: 08035715272

MOHAMMAD, Ibrahim[1]
Email Address: Lawanng2014@gmail.com;
Phone Number: 08075382048

HAMMA, Robert Arab[1]
Email Address: roberto4lynn@gmail.com;
Phone Number: 07037203600

Department of Public Administration, Federal Polytechnic Kaltungo, Gombe State, Nigeria

Abstract

Early Childhood Education (ECE) forms a fundamental stage of a child's socio-psychological, physical and healthy development and in the long-run contributes immensely in the future growth and development of the child to adulthood. Therefore, the advocacy for adequate and equal accessibility of early childhood education to every child irrespective of socio-economic background, gender, race, religion or tribe has in recent times gained much attention across the globe. This is in-line with its associated positive impacts of ECE in shaping the cognitive, emotional, physical, social, and mental parts of a child. The truth that well trained child from birth tends to turn out more responsible citizen than those without adequate early childhood care and education is unarguably right. Early childhood education promotes a nation's development in terms of qualified manpower and build strong national security. It reduces insecurity by reducing some risk factors that breed insecurity such as poverty, inequality, social unrest, drug abuse, unemployment, among others. This paper examines the early childhood education as a panacea in reducing insecurity in Nigeria. Some hiccups which hinder the effective implementation of early childhood education in Nigeria were unmasked which include poor involvement by the government, inadequate supervision, inadequate educational facilities, and poor-quality teachers. Lastly, the paper proffers some pragmatic measures that would strengthen the implementation of early childhood education as a development strategic in fighting and reducing insecurity in Nigeria.

Keywords: Early Childhood Education, National Development and Issues of Insecurity

Introduction

Education apart from being a process of learning, is also a means to achieve sustainable development in all sectors of the society be it – social, economic, technology, environmental, engineering, medicine, among others. This is why the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2006) defined education as the process by which societies deliberately transmit their accumulated information, knowledge, understanding, attitudes, values, skills, competencies and behaviors across generation for societal development. The above definition, depicts and summarizes education as a complex system with many interconnected subsystems and stakeholders. In other words, education becomes a pivotal tool through which societal decision-making is gazette to achieve developmental goals. From the wide perspective approach of the World Bank Report of 2024, education is a human right and a powerful driver of development. It is one of the strongest instruments for reducing poverty and improving health, gender equity, peace, and stability.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026339

Education delivers large, consistent returns in terms of income, and is the most important factor to ensure equity and inclusion.

Education as we know is the transmission of knowledge, skill, attitude, ideas which will enable an individual to survive in any society (Atakpo, 2014). The expected primary aim of education is to bring s sustainable change and modification in mental, social and behavioral background formations of an individual. Explicitly, Oputa (1998) captures it in his statement when he stated that education is a process that prepares the moral character of a child, teaches the fundamental and basic truth, inspire and directs the child's behaviors in all his/her contacts with fellowmen, enable him/her to make correct choices and act responsibly. Going by the above, the importance of Early Childhood Education (ECE) in any society is unarguably and cannot be overemphasized. Nigeria's educational system is yet to tap the opportunities and advantages in early childhood education to harness the teeming population of the youth from early age to overcome some of the challenges of life such as poverty, unemployment and unequal accessibility to education. The school enrollment in the country is still low with many recorded number of school dropouts (UNESCO, 2007). There is increasing evidence that investing in early childhood education is a strategic imperative for national security as it fosters a skilled and productive workforce, enhances social cohesion and community resilience, supports in early intervention and prevention of social ills, promotes inclusive and equitable development and encourages a culture of peace, tolerance and understanding.

Concept of Early Childhood Education

The concept of Early Childhood Education (ECE) covers quite a number of training activities and care in a child's life. It is important to approach the concept holistically to bring out its basic trajectories and expectations. Education as we all know is one of the key factors that help in human development. From the psychological point of view, education at infant year starts from the earliest age of a child's birth and as a child grows to interact with his/her environments. The social relationships with his/her immediate families, cultural practices/norms, religious beliefs, etc. are all important in shaping a child's growth and development. From this point of view, Early Childhood Education refers to all formal and informal learning processes and services for the young children as early childhood support (Amough, 2017). This includes all kinds of education taking place before compulsory schooling and provided in different kinds of settings-nurseries, crèches, childcare centres, kindergartens, pre-schools, and other similar institutions (Congress Resolution on Early Childhood education, Kamerman, 2001; Kamerman and Gatenio, 2003; Plantenga and Siegel, 2004). In a similar view, (Maduewesi, 1999) defined it as the education offered to children who have not yet reached the statutory age of beginning primary school. The (FRN, 2004) refers to Early Childhood Education as an education given in an educational institution to children aged 1 – 5 plus prior to their enrollment in the primary school. Early Childhood Education (ECE) provides learning and education activities with a holistic approach to support children's early cognitive, physical, social and emotional development and introduces young children to organized instruction outside of the family context to develop some of the skills needed for academic readiness and to prepare them for entry into primary education (Caillods, 2006).

Early Childhood Education as Ololube, et al., 2009) emphasized provides the foundation of education in the pre-school education which forms an integral part of a child's early education, given formally or informally, in an educational institution to children ages two-five years prior to entering the primary school. Early childhood is the most critical period in human development, thus comprehensive and quality early childhood education can make a significant contribution to the

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026339

physical psychomotor, cognitive, social and emotional development of the child; including the acquisition of languages and early literacy. Early childhood education might be considered to be education which takes place before compulsory education. The term refers to education in its broadest sense, including childcare and development. This includes early childhood services provided in kindergartens, nurseries, pre-school classes, child-care centers and other similar institutions (Amough, 2017).

Objectives of Early Childhood Education

From the Federal Republic of Nigeria (2004), the objectives of the Early Childhood Education are:

1. Effect a smooth transition from home to school
2. Prepare the child for the primary level of education
3. Provide adequate care and supervision for the children while their parents are at work (on the farm, in the market or offices)
4. Inculcate social norms
5. Inculcate in the child the spirit of inquiry and creativity through the exploration of nature, the environment, art, music and playing with toys and so on
6. Develop a sense of corporation and team spirit
7. Learn good habits, especially good health habit and
8. Teach the rudiments of numbers, letters, colors, form sand so on through play.

Policy Framework for Implementation of Early Childhood Education in Nigeria

As a result of the pivotal importance of education to the individual's life and existence as well as societal or national development, Nigeria has keyed into the global partnership to implement policies and prgrammes aimed towards a sustainable development through early childhood education. Government as the umpire in the management of educational sector has done this through its public institutions and agencies to implement the approved policy guidelines as part of the effort to make Early Childhood Education an integral part of the Nigerian educational system. The policy guidelines for preschool education came into being following the presidential regulation No. 60 of 2013 as stated "implementation of holistic-integrative early childhood development serves toward the realization of healthy, intelligent, cheerful and noble children and the realization of the commitment of all relevant elements, namely parent, families communities, government and local government, in the effort of holistic- integrative early childhood development. The federal government, in collaboration with the world development partners such as UNICEF, UNESCO, World Bank, produced national curriculum for the education of pre-primary education as a guide (Amough, 2017). Also, noted from (Salami, 2016; Agu and Olutola, 2023; Nungala, 2024), in 2014, the government provided a curriculum called one-year pre-primary school education curriculum for the Nigeria children. Besides the curricula, several other policy documents which were enacted to provide to guide the implementation of early childhood Education in Nigeria include:

1. National Policy of Education (NERDC, 2014).
2. National minimum standard for early childhood care centers in Nigeria (NERCD 2007).
3. National Policy for Integrated Early Childhood Development in Nigeria (NERDC 2017).
4. Guidelines for implementing a National policy on integrated early childhood development in Nigeria (FME, 2013).
5. Early childhood development standard for Nigeria (FME).

The Role of Government in Early Childhood Education

Government has a critical and essential role to play in the implementation of early childhood education. This is why Ibeh (2012) emphasized that the role of government in ensuring the success

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026339

of the Early Childhood Education is essentially inevitable. In other words, government the key roles in policy implementation are planning, organizing, coordinating, directing and evaluating policy results in line with the set goals (Onah, 2006). To perform these roles, government must work in partnership with all stakeholders. The Federal and State Ministries of Education oversee the responsibilities of issuing approval permits for educational institutions which wish to go into establishment of early childhood education. Also, the moderation of the teaching curriculums, inspection of the intended physical structures to house the children, environmental feasibility assessment as well as the assessment of the human resources to man the preschool centres are on the expected functions of the government. The effectiveness commitment to these roles will guarantee the success of the primary objectives of the Early Childhood Education and national development.

The National Policy for Integrated Early Childhood Development in Nigeria under page 16 outlined that all relevant government ministries and agencies at the Federal and State levels have the following role in the implementation of the policy. These are:

1. Ensuring policy sensitization and advocacy for IECD involvement
2. Making provisions especially for IECD activities and programmes in the ministries' line budget.
3. Active participation in the National/State IECD Coordinating Committee
4. Monitoring and evaluating IECD implementation involvement for effective baseline data inputs and feedback for the National Coordinating Committee
5. Facilitating IECD-related research. However, for the purpose of ensuring impact creation, specific ministries and their agencies at Federal and State levels shall ensure the following specific roles and functions in IECD implementation (National Policy for Integrated Early Childhood Development in Nigeria, 2017).

The Place of Early Childhood Education in Tackling Insecurity in Nigeria

Early Childhood Education (ECE) is believed to set a solid foundation for cognitive, social and emotional development of a child. This early development is significant in determining the nature of a nation's human capital, social cohesion, economic production, and innovations in science and technology and above all the national security. National security is achieved when both the governed (ruled) and govern (rulers) are respecters of the law. The report of the Council for a Strong America in 2017 on early childhood education states that children who receive adequate care and learning from earliest stages of their lives are likely to follow those positive virtues to adulthood. They are more stable and committed in schooling and building more careers for themselves which make them better personalities in the societies. It further stated that early childhood can reduce problems of crime, drug abuse and other social deviances among children which if not addressed early on in children's live, would put a nation at risk – one that will leave the nation vulnerable for years to come and threaten the strength of the national security. Numerous research studies show that the early years of life have a significant impact on educational attainment, behaviors and health. This helps to explain why high-quality early interventions can help vulnerable children succeed in school, stay on the right side of the law and achieve a healthy weight in the long term. Early Childhood Education comes with a lot of physical and mental learning activities that intend to stay healthy. Teaching of children within the age bracket in the early childhood usually is done through using of toys, music, dancing, playing among others which stimulate them mentally and physically (Agba, et al., 2022; Mallah, et al., 2022; Tanko and Tanko, 2023).

However, random observation shows that most educational centers in Nigeria lack these basic necessities to ensure quality learning environment for the early childhood education. The country in

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026339

recent times has witnessed incessant cases of insecurity. In a study conducted by (Agba et al., 2022) revealed that education in Nigeria has faced a lot of challenges – one of the major challenges being the abduction of students across the states in Nigeria. The abduction of school children applies to all age including those within age 2 -5 years who attend pre-primary schools. The abduction of school children in Chibok, Borno state where over 276 school girls were abducted from their dormitories was one of the big concerns of insecurity in the Nigerian educational system. Also, the kidnapping of 110 Dapchi schoolgirls on 19 February, 2018 from Government Girls Science and Technical College, Dapchi, Yunusari Local Government Area, Yobe State and abduction of 344 school children in Kankara Local Government Area, Katsina state on December 11, 2020 as well as other cases of abduction of school children across the states in Nigeria leave a big question on national security especially in the educational system. Also, recently, there reports of abductions of 287 school children in March 7, 2024 at Government Secondary School Kuriga, Kaduna state, 15 school children were abducted at a boarding school in Gidan Bakuso of Sokoto state in March 9, 2024. In November 17, 2025, 25 students kidnapped in a school in Kebbi state while another 300 school children were take hostage by gunmen on November 21, 2025 in a Catholic School in Niger state (Amnesty International, 2025). Today, many parents are in fear of sending their children to early childhood education for the fear of being abducted. The truth is that most early childhood educational centres have no security guards and other technological security network to checkmate activities within their schools. This has contributed to poor and inadequate supervision of activities in these educational centres leaving a lot uncheck mated which affect the quality of learning programs and impact created in the lives of the children.

The mushroom establishments of pre-nursery and nursery schools in Nigeria without proper government registration and supervision or inspections by government constituted authorities is a serious security concern considering the alleged atrocities that can occur in these centres. There is tendency that those hired to take care of the children can abuse them either physically or mentally. They have many reported and unreported cases of child abuse, defiling of children, molestation, among others in schools. Observations from some studies revealed that the enrollment of children in pre-nursery and nursery schools in Nigeria shows that about 60 – 70 percent of parents consider enrollment costs (school fees/tuition fees, uniform, instructional materials, etc.), proximity and transportation, and less considerations are placed on the physical structure, environment, sanitation and quality of teachers in most these schools. The implication of this can be negative in the lives of the children where there is poor quality teachers who lack adequate knowledge on what and how to teach and impact knowledge on the children, as well as possessing the compatible socio-psychological behavior to understanding every child under his/her care, maintain a high standard hygiene and devote ample time to watch the activities of these children to avoid any risky activities which may be injuring to their health (Atakpo, 2014; Tanko and Tanko, 2022; Obiweluzor, 2015). All these contribute to increase the level of insecurity in the educational sector in Nigeria owing to the fact that insecurity could be in multifaceted.

Implementation Deficiencies in Early Childhood Education in Nigeria

A number of factors or problems have been identified so far as militating against effective implementation of early childhood education in Nigeria. Some of these factors or problems are:

Ineffective and inadequate Policy Framework: The National Policy on Education as well as other supporting policies for the early childhood education do not provide a well detailed policy framework for effective implementation. For example, the policy document at Section 7.0 which contains the

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026339

National and State IECD coordinating committees looks ambiguous about the ministerial sector roles of over ten ministries included in the coordination of ECE.

Poor Standard Operating Procedures of Educational Institutions: Most educational institutions that provide early childhood education do not a unified Standard Operating Procedures (SOP) to ensure that all activities are strictly followed. This problem stems from the perceived inadequate government participation.

Poor Quality and Qualification of Teacher: It is one thing to have teachers, it is another thing to have quality and qualified teachers who can do the job effectively. Early childhood education required well experienced and trained teachers which many of them are graduates from universities and other tertiary institutions. Most educational institutions shortchange the recruitment by engaging persons with lower training and qualifications to cut running costs of hiring manpower which on the other hand, affect the quality of teaching giving to children.

Inadequate Educational Facilities: The quality of teaching and learning process is measured from both the availability of educational facilities in an educational institution. Most schools in Nigeria especially those for early childhood education lack basic educational facilities such as enough playing grounds, toys, televisions to display educative movies for children, music equipment, among others that are necessary for build good cognitive, emotional and social development.

Inadequate Government Involvement and Presence: There seems to be inadequate involvement and presence of the government at all level – federal, state and local government. The only time government is present is during collection of taxes from the school owners. The aspects of financial obligations by government are neglected and abandoned. The financial responsibilities of the implementation of the National Policy on Integrated Early Childhood Education are shared among the stakeholders with the National/Federal Government overseeing the following:

1. Provide adequate funding for basic infrastructures like water, electricity, good roads, and hospitals necessary to support ECD activities nationwide.
2. Meet all costs relating to standard maintenance and supervision of ECD facilities and Pre Schools to ensure quality service delivery.
3. Establish and adequately fund a national specialized resource centre for ECD to serve as a research and information base for ECD.
4. Provide fund to support organization/participation of local ECD professionals in national and international conferences.

On other hand and states and local governments are to provide the following:

State Government:

1. Ensure child friendly schooling for pre-school children through provision and funding of infrastructures, play equipment, and other essential learning packages necessary to keep young children happy and stimulate their interest in learning.
2. Provide baby/child friendly hospitals/clinics environment and services for children 0-5 years by equipping hospitals/clinics with up-to-date medical facilities including personnel.
3. Provide fund for all recurrent expenditures relating to operation and maintenance of publicly owned preschool/Day Care facilities (e.g. teachers/caregivers' salaries, salaries of health workers, electricity and water provision)
4. Provide one school meal to children enrolled in public Pre-school facilities

Local Government:

1. Fund training requirements of Caregivers and teachers
2. Fund and manage the Health Centres, Clinics and Pre-School/Day Care facilities

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026339

3. Provide fund for establishment of crèches, Day Care Centres as required in the local communities (National Policy for Integrated Early Childhood Development in Nigeria, 2017).

Inadequate and Ineffective Supervision: Supervision is one of key management function to ensure seamless flow of work activities, ensure effective management of both human and material resources, identify management gaps or lapses and work towards surmounting the lapses. Supervision of educational activities except the provision of educational curriculums by government in Nigeria is still very poor. Many schools exist with poor state of physical infrastructures, toilets, portable drinking water, safety guides, and other healthcare requirements like first aids and hygiene practices. Also, there poor supervision of monetary charges, text books and instructional materials given to children by school owners from parents.

Strategic Pathways to Ensure Effective Implementation of Early Childhood Education

This paper is invincible that early childhood education in Nigeria will yield more positive results and strength national security if the proffered measures are taking into cognizance by policymakers in all educational system.

1. Increasing Government Active Participation: Government must increase its activities, involvement and presence in the implementation of early childhood education. The role of government in ensuring that the objectives of the early childhood education are realized in Nigeria is inevitable and cannot be overemphasized. The ministries of education both at federal and state level should take adequate responsibilities in all ramifications to ensure effective implementation of the policy guidelines.
2. Ensuring Adequate Funding of Early Childhood Education: There is need to ensure adequate funding of early childhood education in all tier of the government. Enacting policies without ensuring adequate funding or financing leads to failure. Good financial commitment by all stakeholders is important. Government can establish and make available special intervention funds to assist school owners owing to the fact that most early childhood education centres in the country are owned and managed by private sector. For example, countries like United States of America has funded the early childhood education through Preschool Development Grants (PDG) and Child Care and Development Block Grant (CCDBG).
3. Training of Teachers: Training is an important aspect of career development which must be provided for teachers in all educational institutions especially teachers and caregivers in early childhood education centres. This is because early childhood education requires special care, teaching styles and psycho-social relationships with children both those who physically normal and physically challenged to learn.
4. Motivation of Teachers and Caregivers: Both government and school owners should see the need to motivate the teachers and caregivers to children in early childhood education. This is owing to the fact that teaching and taking care of the children at this age bracket is not an easy task. Both the teachers and caregivers are saddled with the responsibilities of feeding, changing of diapers, washing of hands, clothes, singing children to sleep, carefully taking them to play, etc. which are really tasking and demanding cautions.
5. Regular Inspection of the Educational Centres by Government Agencies: Regular inspection and supervision are required to ensure that all the required standards of learning activities are maintained by school owners. It is expected that when government agencies are up and doing in their inspectional and supervisory responsibilities, school owners would also take active

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026339

supervisory roles to avoid being fined by government or even risked closing down their schools because of unscrupulous activities.

6. Provision of Adequate Security: Last but not the least is provision of adequate security in schools and study centres. Security is important to safeguard lives and properties of both children, teachers, caregivers and properties of people providing teaching and care to the children. With adequate security network, the enrollment of the children will increase especially from parents who have refused to enroll the children on the fear of being abducted and on the fear of other activities which might be harmful to their children.

Conclusion

Our discussion so far on early childhood education focuses building a solid foundation for children through education. The integration of early childhood education into the National Policy on Education serves as a strategic pathway to ensure equal access to quality high care education for Nigerian children. However, the targeted aims or objectives this integration has not yielded the desired results as preparatory ground and solid foundation for Nigerian children when compared with other countries like the United States of America, United Kingdom, and many other African nations. The primary reasons being the inadequacy and ineffective involvement of government in the implementation of policy guidelines as contained in the National Policy on Education. Also, incessant cases of kidnapping of school children has also contributed to low enrollment of children in pre-nursery and nursery schools by many parents on the fear of their children being abducted or kidnapped. The issue of poor educational facilities and supervision are seriously affecting the early childhood education in Nigeria. There have some reported cases of some schools giving children sleeping pills, poor sanitized learning environment which endangers the health of these children kept under the watch and care of the school owners. The uncoordinated and porosity in granting permissions for anybody who wants to establish preschool centre without a detailed profiling background checks contributes to insecurity issues which affect early childhood education in Nigeria.

References

Agba, R. U., Ejekwu, P. O. and Ndifon, F. O. (2022) Early Childhood Care Education and the Challenges of Insecurity in Nigeria'. *Multidisciplinary Journal of Research Development*, Vol. 31, No. 1.

Agu, J. C. and Olutola, A. T. (2023) 'Examining the Challenges of Early Childhood Education in Nigeria'. *Indonesian Journal of Educational Research and Technology* – retrieved from htt://ejournal.upi.edu/index.php/IJERT.

Amnesty International Report (2025) 'Nigeria: Generation of Children at Risk of Missing Education in the North'. Report of BokoHaram Abductions in Schools Across Norther Nigeria, 25 November 2025.

Caillods, F. (2006) Early Childhood Education: International Standard Classification of Education. UNESCO Document.

Council for a Strong America (2017) Vision and Mission on Early Childhood Education in America.

Ejieh, M. U. C. (2006) Pre-Primary Education in Nigeria: Policy Implementation and Problems. Retrieved from http//:ikogretin-onlin.org.tr on the 19th February, 2025.

Ewokor, S. (2024) Nigeria Abduction: Fifteen more Students Kidnapped as Army Search Continues. BBC News, 9th March.

Federal Government of Nigeria (2004) The Compulsory Free Universal Basic Education and other Related Matters Act. Lagos: Government Printer.

Federal Government of Nigeria (2004) National Policy on Education (4th Edition). Lagos: NERDC Press.

Ibeh (20

Maduewesi, E. J. (1999) *Early Childhood Education, Theory and Practice*. Lagos: Macmillan Nigeria Publishers Limited.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026339

Mallah, E. U., Ekeada, C. and Maria-Assumpta, A. O. (2022) 'Early Childhood Care Education, Good Governance and Challenges of Insecurity in Nigeria'. *Multidisciplinary Journal of Research Development*, Vol. 3, No.1.

Nungal, U. I. (2024) 'Early Childhood Care Education (ECCE) and National Security'. Solo *International Collaboration and Publication of Social Sciences and Humanities*. Vol. 2, No. 3, pp. 282 – 293.

Nwangwu, I. (2002) 'Education for Peace and Stability in Africa'. *Journal of Liberal Studies*, Vol. 10, No. 1, June.

Obiweluzor, N. (2015) 'Early Childhood Education in Nigeria, Policy Implementation: Critique and a way Forward'. *African Journal of Teacher Education*. Vol. 4, No. 4.

Oputa, C. (1998). To Restore the Dignity of Man: The Role of the University. Hill Front Lecture .New General Books.

Salami, I. A. (2016) Nigerian Early Childhood Education Policies and Practices for Sustainability. European Journal of Research and Reflection in Educational Sciences. Vol. 4, No. 5, 2016.

Tanko, B. A. and Tanko, L. (2023) *'Impact of Insecurity on the Education of the Girl-Child: The Role of Basic Educators in Nigeria'*. International Journal of Innovative Psychology and Social Development. Vol. 11, No. 4, pp. 97 – 102.

Tombowua, S. (2013) Early Childhood Education in Nigeria: Issues and Problems'. Journal of Educational and Social Research, Vol. 3, No. 5. August.

UNESCO (2007) Nigeria Early Chilhood Care and Education (ECCE) Programmes, International Bureau of Education (IBE).

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026340

Effect of Gamification Teaching Method on Academic Performance in Set Theory Concept among Senior Secondary School Students' in Kebbi Metropolis, Kebbi State, Nigeria

UMAR, Nafisa Muhammad[1]
nafisaumar2016@gmail.com,
08147377906

HASSAN, Muhammad Nasiru[1]
nashas4joy@gmail.com,
08067788633

TAMBUWAL, Nasiru I.[1]
nasiru.tambuwal@ssu.edu,ng,
08036084320
[1]Department of Science Education, Faculty of Education, Sokoto State University, Sokoto State, Nigeria

Abstract

This study examined the effect of the gamification teaching method on senior secondary school students' academic performance in set theory in Kebbi State, Nigeria. Specifically, the study sought to determine the difference in academic performance between students taught set theory using the gamification method and those taught using the demonstration method, as well as to examine the difference in performance scores of male and female students taught set theory using the gamification method. To address these, a non-randomized control group, pretest–posttest quasi-experimental design was used. The sample consisted of 357 SSII students selected from four public secondary schools. Data were collected using the Students' Set Theory Performance Test (SSTPT) with a reliability of 0.84. Mean and standard deviation were used to answer the research questions, while an independent sample t-test was used to test the hypotheses at 0.05 significance level. Findings showed that students taught with gamification performed significantly better than those taught with the demonstration method. Results also indicated no significant difference in the performance of male and female students taught with gamification. The study concludes that gamification is an effective alternative to demonstration method and recommends its use for teaching Set Theory, and further studies can be conducted on other mathematics topics.

Keywords: Performance, Gamification, Demonstration, set-theory

Introduction

Set Theory is a foundational topic in the Nigerian senior secondary school mathematics curriculum, designed to develop students' logical reasoning, problem-solving skills, and understanding of mathematical relationships (Salah, 2025). It serves as a prerequisite for topics such as algebra, probability, statistics, and logic, and it frequently appears in external examinations such as the West African Senior School Certificate Examination (WASSCE). The curriculum recognizes Set Theory as essential because it enables students to interpret symbols, classify objects, and analyze relationships systematically. More broadly, Set Theory is a fundamental branch of mathematics that underpins areas such as algebra, topology, and computer science, where concepts like union, intersection, and Cartesian products are applied (Hrbacek & Jech, 2017; Oden & Demkowicz, 2017). It strengthens critical and abstract thinking skills that are necessary for STEM-related disciplines (Szabo, Körtesi, Guncaga, Szabo & Neag, 2020). However, despite its importance, many students struggle with its abstract concepts, which often results in misconceptions and poor performance in examinations (Oladejo, Olateju, Okebukola, Agboluaje, Sanni, Shabani & Ebisin, 2023). In Nigeria, mathematics

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026340

is a core subject, and Set Theory is introduced early because it develops logical reasoning and problem-solving skills (Okotie & Agir, 2024). However, traditional teaching methods often fail to actively engage students, leading to low understanding and poor performance (Makinde & Yusuf, 2017; Akanmu, 2019; Sholihah, 2024). Reports from WAEC Chief Examiners (2018–2024) show recurring difficulties in Set Theory, with many students unable to interpret set notations correctly, construct accurate Venn diagrams, or apply set operations properly. Researchers attribute these challenges to the abstract nature of the topic, inadequate instructional materials, and over-reliance on teacher-centered approaches (Awuah, 2018; Shankar, 2021; Bainbridge et al., 2022; Okpara & Ezeador, 2024). To address these concerns, gamification has emerged as an innovative instructional approach that integrates game elements such as Hula Hoops, points, and rewards to increase motivation and participation (Pawa et al., 2020; Saleem, Noori & Ozdamli, 2022). In teaching Set Theory, Hula Hoops can be used to physically model sets, where overlapping hoops clearly represent union, intersection, and complement, thereby transforming abstract concepts into concrete and visual experiences. This hands-on strategy allows students to actively manipulate set relationships, helping to reduce misconceptions. Studies indicate that gamification enhances conceptual understanding, collaboration, and problem-solving skills (Arufe Giráldez et al., 2022; Zainuddin et al., 2020; Thampy et al., 2023), and improves overall engagement and comprehension (Samala et al., 2024). However, some studies report that gamification may not always lead to significant academic improvement and may produce gender differences if poorly implemented (Hanus & Fox, 2015; Parajuli & Thapa, 2017). Therefore, when carefully designed and properly applied, innovative tools such as Hula Hoops can make abstract Set Theory concepts more meaningful and engaging, helping to address persistent learning difficulties.

In Nigeria, several scholars have emphasized the importance of gamified instructional strategies in improving mathematics learning. For example, Attah, Ogunlade, and Otemuyiwa (2024) found that gamification significantly enhanced teaching effectiveness and students' learning outcomes in mathematics compared to conventional methods, and they recommended its adoption to reduce the abstract nature of mathematics topics. Similarly, Aliyu, Lawal, Muhammad, and Lamido (2025) reported that students exposed to gamified instruction demonstrated higher motivation and better conceptual understanding than those taught using traditional approaches. Gamification is particularly relevant in rural areas such as Kebbi State, where limited instructional resources and predominantly teacher-centered methods have contributed to persistent poor performance in mathematics (Fakai et al., 2024). In response, the Kebbi State Universal Basic Education Board (SUBEB) has organized workshops, mathematics clubs, and community-based programmes to strengthen students' problem-solving skills (Bala & Abdulwahab, 2024). Ideally, the teaching and learning of Set Theory at the senior secondary level should enable students to develop strong foundational skills in mathematics. Students are expected to understand key concepts such as union, intersection, complement, and Venn diagrams in order to perform well in examinations and progress into STEM-related fields. However, the reality in Kebbi State shows that many students lack these basic skills. They often struggle to interpret set symbols, construct accurate Venn diagrams, and apply set notation correctly. WAEC Chief Examiners' Reports (2019) consistently highlight these recurring weaknesses. The continued reliance on traditional, teacher-centered methods has left many students passive and disengaged, limiting deep understanding and real-life application of Set Theory concepts. The consequence of these challenges is widespread low achievement in mathematics, reduced confidence among learners, and continued poor performance in national examinations. This situation raises serious concerns for parents, educators, school administrators,

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026340

and policymakers who expect improved outcomes in mathematics education. Although international studies suggest that gamification can enhance understanding and performance in abstract mathematical topics, limited empirical evidence exists within the context of Kebbi State. Therefore, this study seeks to fill this gap by investigating the effect of the gamification teaching method on senior secondary school students' academic performance in Set Theory in Kebbi State, Nigeria. Due to security challenges in some parts of the state, the study was limited to selected schools within Kebbi State metropolis, where it was safer and more accessible to conduct the research.

Research Objectives

1. Determine the difference in the academic performance score of senior secondary school students taught set theory using gamification method and those taught using Demonstration method in Kebbi State, Metropolis.
2. Examine the difference performance scores of male and female students taught set theory using gamification method among Senior Secondary in Kebbi State, Metropolis.

Research Questions

1. What is the difference in the academic performance score of senior secondary school students taught set theory using gamification method and those taught using Demonstration method in Kebbi State, Metropolis?
2. What is the difference in the performance scores of male and female students taught set theory using gamification method among Senior Secondary in Kebbi State, Metropolis?

Research Hypothesis

1. There is no significant difference in the academic performance score of senior secondary school students taught set theory using the gamification method and those taught using Demonstration method in Kebbi State, Metropolis.
2. There is no significance difference in the mean academic performance scores of male and female students taught set theory using gamification method among Senior Secondary Students in Kebbi State, Metropolis.

Methodology

The researcher employed a non-randomized control group, pretest–posttest quasi-experimental design. The population comprised 6882 Senior Secondary School Two (SS2) students in Kebbi State Metropolis. Among them, 3958 are male students and 2924 are female students. From the population, a sample of 357 SS II students were obtained using Krejcie and Morgan's table (1970) for sample size determination. Four (4) schools were randomly selected using simple random sampling technique. Intact classes were used in each school to avoid distortion in their normal school settings. The detail of the sample is presented in table 1.

Table 1: Sample of the Study

S/N	School	Group	Number of students
1	School A	Experimental	58
2	School B	Experimental	74
3	School C	Control	150
4	School D	Control	75
			357

Students' Set Theory Performance Test for SSII (SSTPT) instrument was used for data collection in this study. The SSTPT was used to measure students' performance in set theory. It consisted of 30 objective test items adopted from relevant external examination bodies (WAEC, NECO JAMB). Each item had four options (A–D), with one correct answer carrying one mark, giving a maximum score of

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026340

30 marks. The items were structured to reflect the six levels of Bloom's taxonomy, thereby ensuring balanced coverage of content. To establish validity and reliability, the instrument was reviewed by experts in mathematics education and subjected to a pilot study in one of the secondary school parts of the population but out of sample using 40 students. The analysis yielded (Reliability=0.84), confirming their suitability for the main study. A pretest was administered to determine the equivalence of groups before treatment. The treatment lasted for six weeks, after which a posttest was conducted using the same instrument to evaluate the effectiveness of the instructional strategies. After marking session, the scores obtained from the study were subjected to analysis using SPSS Statistics. Descriptive statistics of mean and standard deviation were used to answer research questions, while independent sample T-test was used to test the null hypotheses at $\propto = 0.05$ level of significance. The results revealed the following;

Research Question One

What is the difference in the academic performance score of senior secondary school students taught set theory using gamification method and those taught using Demonstration method in Kebbi State, Nigeria? The result of the analysis is presented in table 2.

Table 2: Mean Academic Performance Scores of SS2 Students taught Set Theory using Gamification Method and those taught with Demonstration Method

Group	N	Mean	Std. Deviation	Mean difference	95% Confidence Interval of the Difference	
					Lower	Upper
Gamification	132	21.40	3.852	6.655	5.820	7.489
Demonstration	225	14.75	3.880			
Total	**357**					

Table 2 shows the mean academic performance scores of SS2 students who were taught set theory using the gamification method and those taught with the demonstration method. The result indicated that students in the gamification group had a higher mean score (21.40) compared to those in the demonstration group (14.75). This means that, on average, students exposed to gamification performed better in the test than those taught with the demonstration method. The standard deviations for both groups are almost the same (3.852 and 3.880), suggesting that the spread of scores within each group was similar. The mean difference between the two groups is 6.655, and the 95% confidence interval (5.820 to 7.489) shows that this difference is meaningful and not due to chance.

Research Question Two

What are the mean academic performance scores of SS2 male and female students taught set theory using gamification method in Kebbi State, Nigeria?

The result of the analysis is presented in Table 3.

Table 3: Mean Academic Performance Scores of Male and Female Students taught using Gamification Method

Gender	N	Mean	Std. Deviation	Std. Error Mean	Mean difference	95% Confidence Interval of the Difference	
						Lower	Upper
Male	74	21.59	4.013	.467	.439	-.900	1.779
Female	58	21.16	3.655	.480			
Total	**132**						

Table 3 shows the mean academic performance of male and female students taught Set Theory using the gamification method. The results indicated that male students had a mean score of 21.59, while

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026340

female students had a mean score of 21.16. The small mean difference of 0.439 suggesting that both groups performed almost the same. The confidence interval also shows that this difference is not statistically significant. Therefore, the findings indicated that the gamification method benefited both male and female students equally.

Null Hypothesis One

There is no significant difference in the academic performance score of senior secondary school students taught set theory using the gamification method and those taught using Demonstration method in Kebbi State, Nigeria. The null hypothesis was tested using independent sample T-test from the post-test scores of the two independent groups. The result of the analysis is presented in table 4.

Table 4: Independent Samples T-test Results of Students taught Set Theory using Gamification and Demonstration Methods

Group	N	Mean	Std. Deviation	T-value	Df	P-value
Gamification	132	21.40	3.852	15.685	355	.000
Demonstration	225	14.75	3.880			
Total	**357**					

Table 4 shows the Independent Samples t-test comparing the mean scores of students taught Set Theory using the Gamification method and those taught with the Demonstration method. The Gamification group had a much higher mean score (Mean = 21.40, SD = 3.85) compared to the Demonstration group (Mean = 14.75, SD = 3.88). The t-value is 15.685 with a significance value of p = .001, which is less than the 0.05 level. Since $p < 0.05$, this means the difference in performance between the two groups is statistically significant. Therefore, we reject the null hypothesis. This indicates that the Gamification method had a significantly greater effect on students' performance in Set Theory than the Demonstration method.

Null Hypothesis Two

There is no significance difference in the mean academic performance scores of SS2 male and female students taught set theory using gamification method in Kebbi State, Nigeria. The null hypothesis was tested using independent sample T-test from the post-test scores of the two independent groups. The result of the analysis is presented in table 5.

Table 5: Independent Samples T-test Results for Male and Female Students taught Set Theory using Gamification Method

Gender	N	Mean	Std. Deviation	T-value	df	P-value
Male	74	21.59	4.013	.649	130	.517
Female	58	21.16	3.655			
Total	**132**					

Table 5 shows the independent samples t-test comparing the academic performance of male and female students taught Set Theory using the Gamification method. The results indicated that male students had a mean score of 21.59, while female students had a similar mean score of 21.16. The small difference between the two means suggests that both groups performed almost the same under the gamified instruction. The t-test produced a t-value of 0.649 with a p-value of 0.517, which is greater than the 0.05 level of significance. This means there is no statistically significant difference between the performance of male and female students. Since $p > 0.05$, we fail to reject the null hypothesis. Therefore, gender does not significantly influence students' academic performance when the Gamification method is used.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026340

Summary of the Major Findings

The key findings derived from the research questions and hypotheses that guided the study were that:

1. Students taught Set Theory using the gamification method significantly achieved higher academic performance compared to those taught with the demonstration method.
2. There was no significant difference in academic performance between male and female students taught Set Theory using gamification.

Discussion of Findings

The findings for Research Question/Hypothesis One revealed that students taught Set Theory using the gamification method performed significantly better than those taught through the demonstration method. This indicates that game-based learning enhanced students' understanding, participation, and overall academic performance more effectively than traditional teacher-centered approaches. The result supports previous studies (e.g., Pawa et al., 2020; Arufe Giráldez et al., 2022; Bainbridge et al., 2022), which reported that gamification improves engagement and comprehension in abstract mathematical concepts. However, it contrasts with Hanus and Fox (2015), who found that poorly implemented gamification may not improve performance. This suggests that the effectiveness of gamification depends largely on proper design and implementation. The findings for Research Question/Hypothesis Two showed no significant difference in the academic performance of male and female students taught using gamification. This implies that gamified instruction benefits both genders equally. The result aligns with studies such as Akanmu (2019), Pawa et al. (2020), and Makinde and Yusuf (2017), which found no gender gap when student-centered strategies were used. Although Parajuli and Thapa (2017) reported male students performing better than females, the present study demonstrates that well-structured gamification can reduce gender differences and promote equal learning opportunities in mathematics.

Conclusion

This study examined the effectiveness of the gamification method compared with the demonstration method on senior secondary school students' performance in Set Theory in Kebbi State, Nigeria. Based on the findings, it was concluded that gamification significantly improves students' academic performance more than the traditional demonstration approach. Students exposed to gamified instruction showed better understanding and higher achievement, indicating that active and interactive learning enhances mastery of abstract concepts. The study also concluded that gender does not significantly influence the effectiveness of gamification, as both male and female students performed at comparable levels. This suggests that gamification provides equal learning opportunities and supports inclusive classroom practice. Overall, the findings confirm that gamification is an effective and innovative instructional strategy for improving the teaching and learning of Set Theory in senior secondary schools.

Recommendations

Based on the findings and conclusions of this study, the following recommendations are made to improve teaching and learning of Set Theory among senior secondary school students in Kebbi State and beyond:

1. Teachers should adopt the gamification method as a core instructional strategy for teaching Set Theory and other mathematics topics. Since the method significantly improved students' performance.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026340

2. Gender-friendly instructional practices should be maintained, not because gamification shows gender differences, but because its benefits learners equally. Teachers should ensure that both male and female students participate fully in game-based activities and collaborative tasks.

References

Akanmu, M. A. (2019). Effects of think-pair-share on senior school students' performance in mathematics in Ilorin, Nigeria. African Journal of Educational Studies in Mathematics and Sciences, 15(2), 107-116. DOI: 10.4314/ajesms.v15i2.9

Aliyu, Z., Lawal, H. M., Muhammad Bello, A. D. A. M., & Lamido, A. S. (2025). Gamification strategies and their effects on learning motivation and concept mastery in mathematics and science education. *Journal of educational research and development*, *20*(1), 117-122. Http://journals.abu.edu.ng/index.php/jerd/article/view/868

Arufe Giráldez, V., Sanmiguel-Rodríguez, A., Ramos Álvarez, O., & Navarro-Patón, R. (2022). Can gamification influence the academic performance of students?. https://doi.org/10.3390/su14095115

Asy-Syila, A. (2024). Strategies for Enhancing Student Motivation and Achievement. *Mauve Journal De Leardu, 1*(1), 9-15. https://scholar.google.com/scholar

Attah, J. O., Ogunlade, O. O., & Otemuyiwa, B. I. (2024). Effect of gamification-based teaching on junior secondary school student's academic performance in mathematics in Kwara State. *Andragogi: Jurnal Pendidikan dan Pembelajaran*, *4*(2), 153-165. Vol 4 (2), DOI: https://doi.org/10.31538/adrg.v4i2.1325 E-ISSN 2807-8233

Awuah, F. K. (2018). *Grade 12 Learner's Problem-Solving Skills in Probability*. University of South Africa. Un-published thesis https://d1wqtxts1xzle7.cloudfront.net/79136187

Bainbridge, K., Shute, V., Rahimi, S., Liu, Z., Slater, S., Baker, R. S., & D'Mello, S. K. (2022). Does embedding learning supports enhance transfer during game-based learning? *Learning and Instruction, 77*, 101547. https://www.sciencedirect.com/science/article/pii/S0959475221001067

Bala, N., & ABdulwahab, I. B. (2024). Impact Of Modern Ways Of Teaching And Learning Islamic Sciences On Students' Achievement In Kebbi State. *International Journal of Innovative Development and Policy Studies* 12(4):1-10. Web:www.seahipublications.org ISSN: 2467-8465

Belova, N., & Zowada, C. (2020). Innovating higher education via game-based learning on misconceptions. *EducationSciences*, *10*(9),221. https://doi.org/10.3390/educsci10090221

Fakai, U. R., Sa'adu, A., Argungu, M. A., & Aliyu, A. S. (2024). Collaborative Professional Development: A Catalyst for Science Education Reform in Nigeria. *Formosa Journal of Science and Technology*, *3*(9), 2191-2210. ISSN-E: 2964-6804 DOI: https://doi.org/10.55927/fjst.v3i9.11583 https://journal.formosapublisher.org

Ha, T. (2023). *Technology Integration in School-Based Physical Activity* (Doctoral dissertation, University of Northern Colorado) (2023).Dissertations. 970. https://digscholarship.unco.edu/dissertations/970

Hanus, M. D., & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academicperformance. *International Journal of Educational Technology in Higher Education.*161.http://dx.doi.org/10.1016/j.compedu.2014.08.01903601315.

Hrbacek, K., & Jech, T. (2017). *Introduction to set theory, revised and expanded*. Crc Press. Edition3rd Edition First Published1999 eBook Published18 December 2017 DOIhttps://doi.org/10.1201/9781315274096 Pages310 eBook ISBN9781315274096 SubjectsMathematics & Statistics

Korkealehto, K., & Siklander, P. (2018). Enhancing engagement, enjoyment and learning experiences by gamification on an English course for health care students. In *Seminar. net: International*

Journal on Media, Technology and Lifelong Learning (Vol. 14, No. 1, pp. 13-30). Lillehammer UniversityCollege. https://tuhat.helsinki.fi/ws/portalfiles/portal/160578803/2579_Article_Text_9813_1_10_20180628.pdf

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. Educational and Psychological Measurement, 30(3), 607–610. https://doi.org/10.1177/001316447003000308

Lo, C. K., Hew, K. F., & Chen, G. (2017). Toward a set of design principles for mathematics flipped classrooms: A synthesis of research in mathematics education. *Educational Research Review, 22*, 50-73. https://doi.org/10.1016/j.edurev.2017.08.002

Makinde, S. O., & Yusuf, M. O. (2017). The Flipped Classroom: Its Effects on Studentsâ€™ Performance and Retention in Secondary School Mathematics Classroom. International Journal of Innovative Technology Integration in Education, 1(1), 117-126 DOIhttps://doi.org/10.1007/s10639-020-10243

McDonald, C. (2016). STEM Education: A review of the contribution of the disciplines of science, technology, engineering and mathematics. *Science Education International, 27*(4), 530-569. http://hdl.handle.net/10072/380672

Oden, J. T., & Demkowicz, L. (2017). *Applied functional analysis*. Chapman and Hall/CRC. Edition3rd Edition First Published2017, eBook Published30 November 2017, DOIhttps://doi.org/10.1201/9781315119489. Pages632 eBook ISBN9781315119489

Okotie, W., & Agir, E. (2024). National Policy on Education: The Need to Inculcate Logical/Critical Ability to Enhance Tertiary Education in Nigeria. *FUOYE Journal of Public Administration and Management, 2*(1). ISSN: 2992 – 4863 Vol.2 No.1, 2024

Okpara, G. C., & ezeador, C. N. (2024). Philosophy of teaching: exploring various teaching methods for improved education in nigeria. *Nnadiebube journal of philosophy, 7*(3). https://acjol.org/index.php/NJP/article/view/5555

Oladejo, A. I., Olateju, T. T., Okebukola, P. A., Agboluaje, T. M., Sanni, R., Shabani, J., … & Ebisin, A. (2023). The convergence of culture, technology and context: A pathway to reducing Mathophobia and improving achievement in mathematics. *School Science and Mathematics, 123*(2), 82-96. **https://doi.org/10.1111/ssm.12573**

Parajuli, M., & Thapa, A. (2017). Gender differences in the academic performance of students. *Journal of development and social engineering, 3*(1), 39-47. ISSN 2382-5332 © School of Development and Social Engineering, Pokhara University

Pawa, S., Laosinchai, P., Nokkaew, A., & Wongkia, W. (2020). Students' conception of set theory through a board game and an active-learning unit. *International Journal of Innovation in Science and Mathematics Education, 28*(1), pp173-195. https://openjournals.library.sydney.edu.au/CAL/article/download/13568/12929

Saidu, S. (2019). CEO characteristics and firm performance: focus on origin, education and ownership. *Journal of Global Entrepreneurship Research, 9*(1), 29 pp 224-237.DOIhttps://doi.org/10.1186/s40497-019-0153-7

Salah, A. R. M. (2025). Set Theory and Its Foundational Role in Modern Mathematics. https://www.researchgate.net/392963670 /links/685a746fe8fa0f5c28261c2e/.pdf

Saleem, A.N., Noori, N.M. & Ozdamli, F. (2022). Gamification Applications in E-learning: A Literature Review. *Tech Know Learn* 27. Original research Published: 02 January 2021, Volume 27, pages 139–159, (2022). https://doi.org/10.1007/s10758-020-09487-x

Samala, A. D., Bojić, L., Vergara-Rodríguez, D., Klimova, B., & Ranuharja, F. (2024). Exploring the impact of gamification on 21st-century skills: Insights from DOTA 2. International Journal of Interactive Mobile Technologies, 17(18), 33-54. DOI: 10.3991/ijim.v17i18.42161 ISSN: 1865-7923

Shankar, P. M. (2021). Sets, Venn Diagrams, Probability, and Bayes' Rule. In *Probability, Random Variables, and Data Analytics with Engineering Applications* (pp. 5-76). Cham: Springer International Publishing. https://research- /27333114/1/files/50726646.pdf

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026340

Sholihah, f. I. (2024). Innovative Approaches in Mathematics Education: Enhancing Student Uderstanding and Engagement. *Berajah journal*, *4*(5), 1183-1194. ISSN (p): 2797-1805 | ISSN (e): 2797-1082

Smith, N. (2018). Integrating Gamification into Mathematics Instruction: A Qualitative Exploratory Case Study on the Perceptions of Teachers at the Fourth and Fifth Grade Level. *Online Submission*. Un published Dissertation Presented, in Partial Fulfillment of the Requirements for the Degree of Doctorate of Education William Howard Taft University November 2018.

Szabo, Z. K., Körtesi, P., Guncaga, J., Szabo, D., & Neag, R. (2020). Examples of problem-solving strategies in mathematics education supporting the sustainability of 21st-century skills. *Sustainability*, *12*(23), pp 92-121; doi:10.3390/su122310113

Thampy, H., Walsh, J. L., & Harris, B. H. (2023). Playing the game: The educational role of gamified peer-led assessment. *The clinical teacher*, *20*(4), e13594. Received: 17 September 2022 Accepted: 16 May 2023 DOI: 10.1111/tct.13594

West African Examinations Council (WAEC). (2019). Chief Examiner's Report: General Mathematics Paper 2 (WASSCE 2nd Series). Retrieved from https://www.waeconline.org.ng

West African Examinations Council (WAEC). (2020). Chief Examiner's Report: General Mathematics Paper 2. Retrieved from https://www.waeconline.org.ng

West African Examinations Council (WAEC). (2021). Chief Examiner's Report: General Mathematics Paper 2. Retrieved from (https://www.waeconline.org.ng)

Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. *Educational research review*, *30*, pp 232-247. https://doi.org/10.1016/j.edurev.2020.100326

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026341

Evaluation of Validity and Reliability of Pre-Service Geography Teachers' Grit Questionnaire among Colleges of Education in Northwest, Nigeria

NAJIB, Abdullahi
najibabdullahi44@gmail.com
+2348038127213

Department of Science Education, Sule Lamido University Kafin Hausa, Jigawa State, Nigeria

Abstract

This study examined the validity and reliability of the pre-service geography teachers' grit questionnaire (PGTGQ) in Colleges of Education in Northwest Nigeria. A survey research design was adopted and a standard procedure for face, content, and construct validation and reliability testing were followed. Content validity was established through ten (10) experts from geography education, science education, psychology, and test and measurement. The instrument was pilot-tested with a sample of pre-service Geography teachers, and the data were analysed using Cronbach's alpha to assess internal consistency of the instrument. The findings revealed that the Average Expert-Level Face Validity Index (AELFVI) was 0.86, confirming that the questionnaire items were clear and appropriate for measuring pre-service Geography teachers' Grit. A Scale Content Validity Index (S-CVI/Ave) of 0.89 further confirmed that the instrument adequately represented the intended construct. Principal Component Analysis (PCA) showed that ten (10) items with factor loadings greater than 0.40 were retained. The overall reliability coefficient obtained was 0.83, indicating that the instrument was reliable for data collection. Based on these findings, the study concluded that the instrument is valid and reliable to measure the pre-service geography teachers' grit questionnaire in Colleges of Education in Northwest Nigeria and recommended that the PGTGQ can be used to assess pre-service Geography teachers' grit.

Keywords: Grit, Validity, and Reliability.

Introduction

Grit is a non-cognitive attributes that have gained prominence in educational research due to their influence on academic achievement. Grit is defined as passion and perseverance for long-term goals, and it plays a crucial role in academic success by enabling individuals to overcome challenges (Duckworth et al., 2007). In teacher education, grit is particularly important because pre-service teachers must sustain effort in mastering subject matter, pedagogical skills, and teaching practice despite institutional and contextual challenges. Although grit has been widely examined by most of the researchers but most of the measurement instruments were developed and validated in Western contexts (Duckworth & Quinn, 2009). The direct application of such instruments in Nigerian Colleges of Education raises concerns about cultural relevance and psychometric adequacy. Measurement theory emphasizes that instruments must demonstrate acceptable validity and reliability within the population of interest before meaningful interpretation is possible (AERA, APA, & NCME, 2014). Research shows that grit significantly impacts academic achievement across various subjects, though little attention has been paid to pre-service Geography teachers in Northwest Nigerian colleges of education. For instant, Kelly and Zhou (2018) found a strong link between grit and academic achievement, while Doris et al., (2020) confirmed that grit positively affects student performance. Anthony et al., (2020) also found that grit significantly predicts academic achievement. Tugabirwe and Aloysius (2023) revealed a strong association between grit and students' academic performance. Fernandez-Martín et al., (2020) suggested that grit predicts academic achievement. Since researches indicates a positive correlation between grit and academic achievement across disciplines, there is a need to adopted, validated, and find a reliability coefficient of grit questionnaire

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026341

among pre-service Geography teachers' at colleges of education in Northwest Nigeria which remains understudied. This study aims to fill this gap by examining the validity, and reliability of grit questionnaire for pre-service Geography teachers' using both face, content, construct validity, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), alongside reliability indices such as Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE).

Statement of the Problem

Science education research often involves the adoption of existing, or the development of new instruments to measure phenomena of interest (Taber, 2018). The use of poorly validated instruments may result in inconsistent measurements and inaccurate interpretations of findings (Creswell & Creswell, 2018). Despite increasing interest in grit within educational research, there are inadequate empirically validated grit instruments for pre-service Geography teachers' in Nigerian Colleges of Education. Existing studies have often relied on imported scales without subjecting them to rigorous psychometric evaluation, particularly using advanced techniques such as EFA and CFA. Many studies have focused on the development and validation of questionnaires, but limited attention has been given specifically to the grit of pre-service geography teachers'. For example, Duckworth and Quinn (2009) Developed and validated the Short Grit Scale. Bolaji et al. (2020) developed and validated a geography attitudinal scale, while Gurjiya and Danladi (2024) assessed the validity and reliability of a Geography Interest Questionnaire among pre-service teachers in colleges of education in Northwest Nigeria. Similarly, Abdullahi and Danladi (2025) Assess the Validity and Reliability of Pre-Service Geography Teachers' Attitude Questionnaire in Colleges of Education in North-West, Nigeria. Abdullahi and Danladi (2025) Developed and Validation of a Perception Questionnaire for Pre-Service Geography Teachers. However, there is a need to establish the validity and reliability of a Pre-service Geography Teachers' grit Questionnaire to ensure accurate measurement and to strengthen empirical research in geography education within colleges of education.

Objectives of the Study

The main objective of this study was to establish the validity and reliability of grit questionnaire for pre-service Geography teachers in Northwest Colleges of Education in Nigeria. The Specific objectives are to:

1. Find out the face validity of the pre-service Geography teachers' grit questionnaire in colleges of education in north-west, Nigeria.
2. Determine the content validity of the pre-service Geography teachers' grit questionnaire in colleges of education in north-west, Nigeria.
3. Examine the construct validity of the of the pre-service Geography teachers' grit questionnaire in colleges of education in north-west, Nigeria.
4. Assess the reliability (internal consistency) of the pre-service Geography teachers' grit questionnaire in colleges of education in north-west, Nigeria.

Research Questions

This study is guided by the following research questions:

1. What is the face validity of the pre-service Geography teachers' grit questionnaire in colleges of education in north-west, Nigeria?
2. To what extent does the pre-service Geography teachers' grit questionnaire demonstrate content validity in colleges of education in north-west, Nigeria?
3. What is the construct validity of the pre-service Geography teachers' grit questionnaire in colleges of education in north-west, Nigeria?

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026341

4. What is the reliability coefficient of the pre-service Geography teachers' grit questionnaire in colleges of education in north-west, Nigeria?

Methodology

A survey research design was adopted to examine pre-service geography teachers' attitudes toward geography. The survey research design was considered appropriate because it enables the researchers to collected personal and social facts, beliefs, and attitudes of respondents (Oloyede et al., 2011). Another reason for adopting this method is that it involves gathering information or data from a large population by studying a representative sample of the entire group (Abdullahi et al., 2008). The participants comprised pre-service geography teachers from colleges of education in the Northwest Zone of Nigeria. Two (2) colleges of education participated in the study, and a total of two hundred (200) pre-service geography teachers were selected. To assess the grit levels of pre-service Geography teachers' the researcher adapted the Grit Scale originally developed by Duckworth and Quinn (2009), with permission. The instrument assesses two core components of grit: consistency of interest and perseverance of effort. The original response format of the scale are: 5 (Very much like me), 4 (Mostly like me), 3 (Somewhat like me), 2 (Not much like me), and 1 (Not like me at all) was modified by the researcher to a five-point Likert scale: 5 (Strongly Agree), 4 (Agree), 3 (Undecided), 2 (Disagree), and 1 (Strongly Disagree). The questionnaire is divided into two sections. Section A collects demographic information such as age, academic level, admission number, and name of the college. Section B measures the grit of pre-service Geography teachers. Items 1–5 assess consistency of interest, while Items 6–10 assess perseverance of effort To establish the face and content validity of the Pre-service Geography Teacher Attitude Questionnaire, ten (10) academic professionals, ranging in rank from Senior Lecturers to Professors, were selected from the Department of Science Education at Bayero University Kano, the Federal University of Technology Minna, Sule Lamido University Kafin Hausa, and the Department of Geography at Sa'adatu Rimi College of Education, Kano. The experts specialize in Geography Education, Science Education, Psychology, and Statistics, were asked to review the instrument at their convenience. The experts were provided with the questionnaire and a validator's report form for scoring the instrument. They were requested to assess the instrument based on the simplicity of language, clarity of items, and appropriateness and adequacy for the target population. Their observations, comments, corrections, and suggestions made during the validation process were incorporated into the final version of the questionnaire. To determine construct validity, the Pre-service Geography Teacher Grit Questionnaire, Exploratory Factor Analysis (EFA), and Confirmatory Factor Analysis (CFA) were conducted in SPSS Version 27.0 and SPSS AMOS Version 25. The Exploratory Factor Analysis (EFA), Principal Component Analysis (PCA) was used to assess data suitability using the Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity, and PCA factor loadings from the Promax Rotation Method with Kaiser Normalization.
To establish the reliability of the Pre-service Geography Teachers' Grit questionnaire (PGTAQ), a pilot test was conducted involving 30 pre-service Geography teachers from a public College of Education in the Northwest. The reliability coefficient for the PGTGQ was determined using Cronbach's alpha.

Presentation of Results

Research Questions One: - What is the face validity of the pre-service Geography teachers' Grit questionnaire in colleges of education in north-west, Nigeria?

Table 1: Face Validity Index of Pre-service Geography Teachers Grit Questionnaire

Expert	CI (30%)	AP (30%)	A (40%)	E-LVI
1.	25	27	34	86
2.	24	29	37	90
3.	28	28	34	90

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026341

4.	23	26	36	85
5.	26	25	35	86
6.	27	25	36	88
7.	24	27	32	83
8.	29	25	33	87
9.	28	26	34	88
10.	22	24	35	81
AELFVI				**864/10= 86.4**

Key: CI: Clarity of Instructions, AP: Appropriate for the participant, A: Adequate
E-LVI: Experts Logical Validity Index AELFVI: Average Expert Face Logical Validity Index

Table 1 presents the results of the face validity index of the Pre-service Geography Teachers' Grit Questionnaire. The Average Expert-Level Face Validity Index (AELFVI), calculated from the ratings of ten experts, was 86.4, confirming that the instrument is suitable for pilot testing and full-scale data collection as recommended by Desai and Patel (2020). This indicates that the experts agreed that the questionnaire items are clear, appropriate for measuring pre-service geography teachers' Grit, and sufficiently comprehensive in covering the construct of grit.

Research Questions Two: - To what extent does the pre-service Geography teachers' Grit questionnaire demonstrate content validity in colleges of education in north-west, Nigeria?

Table 2: Content validity index of Pre-service Geography Teachers Grit Questionnaire

Items	E 1	E 2	E 3	E 4	E 5	E 6	E 7	E 8	E 9	E 10	E in A	I-CVI	Decision
1.	1	1	1	1	1	1	0	1	1	1	9	0.9	Retain
2.	1	0	1	1	1	1	1	1	1	1	9	0.9	Retain
3.	1	1	1	1	1	1	0	1	1	1	9	0.9	Retain
4.	1	0	1	1	0	1	1	1	1	1	8	0.8	Retain
5.	1	1	1	1	1	1	0	1	1	1	9	0.9	Retain
6.	1	1	0	1	0	1	1	1	1	1	8	0.8	Retain
7.	1	1	1	1	1	1	1	0	1	1	9	0.9	Retain
8.	1	0	1	1	1	1	1	1	1	1	9	0.9	Retain
9.	1	1	1	1	1	1	0	1	1	1	9	0.9	Retain
10.	1	1	1	1	1	1	1	1	1	1	10	1.0	Retain
											S-CVI/Ave	**0.89**	

Key: E= expert, E in A= Expert in agreement, I-CVI= Item content validity index

Table 2 presents the results of the content validity index analysis of the Pre-service Geography Teachers' Grit Questionnaire. The findings indicate that all ten (10) items achieved acceptable Item Content Validity Index (I-CVI) values, ranging from 0.90 to 1.00. Consequently, all items were retained. At the scale level, a Scale Content Validity Index based on the average method (S-CVI/Ave) of 0.89 was obtained, confirming that the instrument adequately represents the construct of pre-service geography teachers' grit.

Research Questions Three: - What is the construct validity of the pre-service Geography teachers' grit questionnaire in colleges of education in north-west, Nigeria?

Table 3: Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity of Pre-service Geography Teacher Grit Questionnaire

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.875
Bartlett's Test of Sphericity	Approx. Chi-Square	5115.067
	Df	66
	Sig.	.000

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026341

The table 3 presents the result of Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity Result. The analysis revealed that the sample used for this study was adequate, with a KMO value of 0.875, df = 66, and p = 0.000. These results indicate that the data were suitable for factor analysis and could be used to determine the construct validity of the instrument using SPSS AMOS. To identify the items to be retained in the questionnaire, Principal Component Analysis (PCA) with the promax rotation method was employed. The results of this analysis are presented in table 4.

Table 4: Principal Component Analysis Factor Loading for Pre-service Geography Teacher Grit Questionnaire

Pattern Matrix[a]

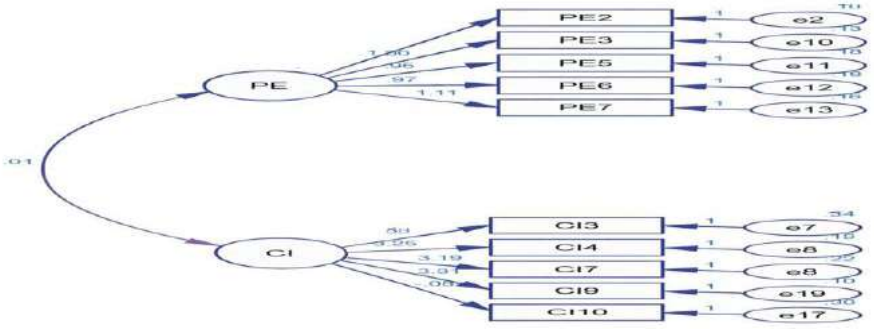
	Items	Component 1	2
CI1	I stay focused on Geography projects until I complete them.	.992	
CI2	I remain committed to my previous Geography ideas even when new ones come up	.963	
CI3	I maintain my focus and interest in Geography-related tasks over time.	.823	
CI4	My interest in Geography remains strong and does not change easily.	.981	
CI5	I stay passionate about Geography ideas and projects for a long time.	.976	
PE1	I keep trying to understand Geography even when I face difficulties.		1.000
PE2	I work hard and remain committed to mastering Geography.		1.000
PE3	I complete whatever I begin in Geography.		1.000
PE4	I never give up on learning Geography, no matter the challenges.		1.000
PE5	I overcome setbacks and continue working hard to achieve success in Geography.		1.000

Key: PE: perseverance of Effort, CI: Consistency of Interest

Table 4 presents the result of the Principal Component Analysis Factor Loading for the Pre-service Geography Teacher Attitude Questionnaire. As recommended by Hair, Black, Babin & Anderson (2014), who suggested that an instrument with good construct validity should have loading values between ± 0.30 and above, this study considers and uses an instrument with good construct validity; therefore, ten (10) items with a loading factor greater than 0.40 are selected.

Confirmatory Factor Analysis of Pre-service Geography Teachers' Grit Questionnaire (PGTGQ)

The items loaded from the exploratory factor analysis are confirmed using confirmatory factor analysis in SPSS AMOS Version 25.0. Fit indices, including the ratio of chi-square to its degrees of freedom (x2/DF ratio), the goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI), the Tucker-Lewis index (TLI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA), were used to determine the model fit. The model is presented in Figure 1.



Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026341

Figure 1: Confirmatory Factor Analysis Model of Pre-service Geography Teachers' Grit Questionnaire (PGTGQ). Key: *CI: Consistency of Interest, PE: Perseverance of Effort*

Figure 1 presents the CFA model of PGTGQ; the fit indices for the model fall within the acceptable range after deleting unloaded and cross-loaded items. Hence, the model fit and ten (10) items are appropriate, valid, and therefore form the items for the final copy of the instrument.

Convergent Validity of Pre-service Geography Teachers' Grit Questionnaire (PGTGQ)

To establish the convergent validity of the PGTGQ, Composite Reliability (CR) and the Average Variance Extracted (AVE) were used. Hair et al., (2019) recommended that convergent validity of the construct is achieved when the average variance extracted (AVE) is ≥ 0.50 and composite reliability (CR) value falls within the range of ≥ 0.70. The result was calculated using Excel Tools, and the result is presented in Table 5.

Table 5: Composite Reliability (CR) and Average Variance Extracted (AVE) Value and Square Root of (AVE) for U, D, and RE and Inter-Factor Correlation of Pre-service Geography Teachers' Grit Questionnaire (PGTGQ)

Factor	CR	AVE	CI	PE
CI	0.782	0.750	**0.866**	
PE	0.822	0.682	0.254	**0.825**

Table 5 presents the Composite Reliability (CR) and Average Variance Extracted (AVE) values for PGTGQ. The analysis revealed that CI and PE had CRs of 0.782 and 0.822, respectively, which are > 0.7, indicating that the constructs are reliable. However, the table also shows the AVE values for CI and PE to be 0.750 and 0.682, respectively, which exceed the acceptance value of 0.50, indicating that all three constructs explain over 50% of the variance in the items that comprise them. Therefore, with these CR and AVE values, the convergent validity of PGTGQ is established, and it is concluded that individual items for each construct converged in comparison to items measuring another construct to measure that particular construct.

Discriminant Validity of Pre-service Geography Teachers' Grit Questionnaire (PGTGQ)

To establish the discriminant validity of the PGTGQ, the Fornell-Larcker criterion was used. Fornell-Larcker (1981) suggested that the square root of the AVE value is compared with the inter-factor correlation, and the inter-factor correlation should be less than the square root of the AVE. The analysis was conducted using Excel Tools, and the results are presented in Table 5. Table also presents the Square Root of Average Variance Extracted (AVE) for CI and PE. The bolded diagonal values are the square roots of the AVEs, and the other values are inter-construct correlations. The requirement is that the diagonal values should be greater than the other values in their respective rows and columns, which is met, as shown in the table. It was therefore concluded that both constructs (CI and PE) empirically distinguish themselves from each other in the PGTGQ and are affirmed to have good discriminant validity.

Research Questions Four: - What is the reliability coefficient of the pre-service Geography teachers' grit questionnaire in colleges of education in north-west, Nigeria?

Table 6: Reliability of Pre-service Geography Teachers' Grit Questionnaire (PGTGQ)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.836	.734	10

Table 6 present the reliability coefficient for the PGTGQ, The internal consistency of the questionnaire items yielded a Cronbach's alpha of 0.83, indicating high reliability.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026341

Discussion of Findings

The findings from Research Question One show that a Face Validity Index of 86.4% was obtained. This result is in line with that of Desai and Patel (2020), who stated that an instrument with a face validity index of 80% to 100% is considered to have full face validity. The findings from Research Question Two indicate that all 10 items achieved acceptable Item Content Validity Index (I-CVI) values, ranging from 0.80 to 1.00. Consequently, all items were retained, and a Scale Content Validity Index based on the average method (S-CVI/Ave) of 0.89 was obtained. This finding agrees with Yusoff (2019), who recommended that acceptable cut-off scores for the CVI should be 0.78 or higher when at least nine experts are involved. Accordingly, this study adopted a cut-off score of 0.78 or above for the content validity index, based on evaluations from ten experts. The findings from Research Question three shows that ten (10) items with factor loadings greater than 0.40 were selected and used in the final instrument. This result is consistent with the recommendation of Hair et al., (2014), who suggested that instruments with good construct validity should have factor loadings of ±0.30 or higher. Based on this criterion, ten (10) items with factor loadings exceeding 0.40 were retained. The findings from Research Question Four indicate that the questionnaire's internal consistency yielded a Cronbach's alpha coefficient of 0.83, indicating high reliability. This finding aligns with Gay et al. (2009), who stated that instruments with Cronbach's alpha values between 0.80 and 0.90 are considered highly reliable.

Conclusion

This study determines the validity and reliability of pre-service Geography teachers' grit questionnaire in Colleges of Education in Northwest Nigeria. The findings of the study provide a comprehensive understanding on how to validate and find a reliability of the grit questionnaire. Based on the results, the following conclusions were made, the instrument demonstrate a good and acceptable Face Validity Index of 86.4%, all the ten (10) items achieved acceptable Item Content Validity Index (I-CVI) values, ranging from 0.80 to 1.00 and a Scale Content Validity Index based on the average method (S-CVI/Ave) of 0.89 was obtained. The result shows that ten (10) items with factor loadings greater than 0.40 were selected and used in the final instrument and the internal consistency yielded a Cronbach's alpha coefficient of 0.83, indicating high reliability. Lastly, the study concluded that the instrument is valid and reliable to measure the pre-service geography teachers' grit at Colleges of Education in Northwest Nigeria

Recommendations

Based on these findings, it is recommended that:

1. The instrument is valid and reliable to measure the pre-service geography teachers' grit.
2. The questionnaire can be refined and revalidated in different cultural or institutional settings to enhance its broader applicability.
3. Researchers, Education stakeholders and teacher educators may use the instrument to measure pre-service geography teachers'.

Acknowledgements

The researcher expresses his sincere gratitude to Duckworth and Quinn (2009) for granting permission to adapt the original instrument. I also thank the expert Validators who evaluated the instrument for face and content validity. Appreciation goes to the Head of the Department of Geography in the sampled colleges of education, as well as to the pre-service Geography teachers' for their time and effort in completing the questionnaire.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026341

References

Abdullahi, A. B., Oluwo, S. K., & Idowu, F. O. (2008). *Research methods and documentation.* Kano-Nigeria. Asasons limited

Abdullahi, N., & Danladi, I.I. (2025). Assessment of the Validity and Reliability of Pre-Service Geography Teachers' Attitude Questionnaire in Colleges of Education in North-West, Nigeria. *Fudma Journal of Educational Research (FUDJER)* 8(2). 366-377.

Abdullahi, N., & Danladi, I.I. (2025). Development and Validation of a Perception Questionnaire for Pre-Service Geography Teachers. *Jigawa Journal of Educational Research (JJER)* 4(2), 212-225 https://jjer.com.ng

American Educational Research Association, American Psychological Association, & National Council on Measurement in Education. (2014). *Standards for educational and psychological testing.* Washington, DC: AERA.

Anthony, A. O., Ernestina, L., & Chei, B. (2020). Is grit the best predictor of university students' academic achievement? *Journal of Education and Practice, 11*(29), 73–82. Retrieved from http://www.iiste.org

Bolaji, A. E., Falaye, F. V., & Junaid, I. O. (2020). Design and validation of geography attitudinal scale. *International Journal of Scientific Research in Education, 13*(4), 689–694.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE

Desai, S., & Patel, N. (2020). ABC of face validity for questionnaire. *International Journal of Pharmaceutical Sciences Review and Research, 65*(1), 164–168. http://www.globalresearchonline.net

Doris, B., Cynthia, M., & Shawn, C. (2020). The relationship between grit and academic performance in the classroom. *Journal for Economic Educators, 20*(2), 1–15.

Duckworth, A. L., & Quinn, P. D. (2009). Development and validation of the Short Grit Scale (Grit–S). *Journal of Personality Assessment, 91*(2), 166–174. https://doi.org/10.1080/00223890802634290

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology, 92*(6), 1087–1101. https://doi.org/10.1037/0022-3514.92.6.1087

Fernández-Martín, F. D., Arco-Tirado, J. L., & Hervás-Torres, M. (2020). Grit as a predictor and outcome of educational, professional, and personal success: A systematic review. *Psicología Educativa, 26*(2), 163–173. https://doi.org/10.5093/psed2020a11

Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. *Journal of Marketing Research, 18*(3), 382–388.

Gay, L. R., Mills, G. E., & Airasian, P. (2009). *Educational research: Competencies for analysis and applications* (9th ed.). Pearson.

Gurjiya, A. U., & Danladi, I. I. (2024). Assessment of validity and reliability of geography interest questionnaire among pre-service teachers in colleges of education, North-West, Nigeria. *Zamfara International Journal of Education, 4*(5), 49–56. https://doi.org/10.5281/zenodo.15029263

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). *Multivariate data analysis* (7th ed.). Pearson Education.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review, 31*(1), 2–24.

Kelly, K. L., & Zhou, M. (2018). Relationship between grit and academic achievement: A systematic review. Paper presented at the Hong Kong International Conference on Education, Psychology and Society. Retrieved from https://www.researchgate.net/publication/331318821

Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). New York, NY: Guilford Press.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026341

Lambert, D., & Morgan, J. (2010). *Teaching geography 11–18: A conceptual approach*. Open University Press.

Oloyede, I. O., Okon, N., Okonkwo, C. A., & Salawu, I. O. (2011). *EDU 823: Educational research methods*. National Open University of Nigeria. http://www.nou.edu.ng

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education, 48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Tugabirwe, I., & Aloysius, R. (2023). Grit predicts academic achievement among undergraduate science teachers at a university of science and technology. *Qeios*, 1–13. https://doi.org/10.32388/MMPITX

Yusoff, M. S. B. (2019). ABC of content validation and content validity index calculation. *Education in Medicine Journal, 11*(2), 49–54. https://doi.org/10.21315/eimj2019.11.2.6

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026342

Comparative Analysis of Workplace Productivity: An Insights from Maslow's Hierarchy of Needs, Herzberg's Two-Factor Theory and Self Determination Theory

OKHAWERE, Paulson Young Ofenimu
Email: gainsp@yahoo.com
Phone: +2349156215770

Federal University of Education, Kontagora, Niger State, Nigeria

Abstract

This study provides a comparative analysis of workplace productivity through the lens of three seminal motivation theories: Maslow's Hierarchy of Needs, Herzberg's Two-Factor Theory, and Self-Determination Theory (SDT). Workplace productivity, defined as the efficient accomplishment of tasks and organizational goals, is closely linked to employee motivation—a dynamic influenced by both intrinsic and extrinsic factors. The research explores how each theory conceptualizes motivation and their implications for enhancing productivity. Maslow's model emphasizes a hierarchical progression of needs from basic physiological survival to self-actualization, suggesting that unmet lower-level needs hinder peak productivity. Herzberg distinguishes between hygiene factors (which prevent dissatisfaction) and motivators (which drive satisfaction), asserting that job content plays a critical role in employee engagement. SDT, meanwhile, prioritizes autonomy, competence, and relatedness as fundamental psychological needs essential for intrinsic motivation and sustained performance. The study contrasts these theories based on their assumptions, empirical validity, and practical relevance in organizational settings. It also examines their application in diverse work environments, including contemporary companies like Google, Ritz-Carlton, and Atlassian. Furthermore, the paper highlights the contextual challenges of implementing these theories in Nigerian workplaces, where economic instability and cultural collectivism often necessitate adaptation of traditional motivation frameworks. Ultimately, the study argues that while no single theory fully captures the complexities of employee motivation, an integrative approach—drawing from the strengths of each model—offers a more effective strategy for fostering productivity and organizational growth. The findings underscore the need for context-sensitive and psychologically grounded human resource practices.

Key Words: Workplace Productivity, motivationn, Maslow's, Herzberg's & Self-Determination Theory

Introduction

Workplace productivity and employee motivation are pivotal components in organizational success, particularly in an increasingly competitive and dynamic business environment. Productivity in the workplace refers to the efficiency with which tasks and goals are accomplished by employees to generate desired outcomes (Drucker, 1999). It is often measured by output per labour hour and influenced by various internal and external factors, including motivation. Motivation, on the other hand, refers to the intrinsic and extrinsic forces that stimulate individuals to take actions that lead to goal achievement (Ryan & Deci, 2000). Understanding the interplay between motivation and productivity is crucial because motivated employees tend to be more engaged, creative, and committed, all of which enhance organizational performance (Herzberg, 1968; Robbins & Judge, 2019). Maslow's Hierarchy of Needs (1943), Herzberg's Two-Factor Theory (1968), and Vroom's Expectancy Theory (1964) have provided foundational frameworks for interpreting employee motivation in organizational settings. These theories suggest that employees are driven by both psychological and material needs, and addressing these needs can significantly enhance productivity. Despite its importance, many organizations face challenges in maintaining optimal productivity due to declining employee morale, inadequate incentives, poor leadership, and lack of alignment between individual and organizational goals (Armstrong & Taylor, 2020). This research

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026342

aims to explore the relationship between employee motivation and workplace productivity, identifying key motivational strategies that can enhance performance. The central research problem is the persistent decline in workplace productivity despite the implementation of various motivational policies. Thus, the objectives of this study are: (1) to examine the impact of motivation on workplace productivity, (2) to evaluate motivational strategies used in organizations, and (3) to recommend effective approaches for sustaining employee engagement and productivity.

Theoretical Foundations of Motivation in the Workplace

Theories of motivation in the workplace provide critical insights into why employees behave the way they do and how organizations can harness this understanding to improve performance. The classical theories of motivation, including Maslow's Hierarchy of Needs (1943), Herzberg's Two-Factor Theory (1959), and McGregor's Theory X and Theory Y (1960), laid the foundation for modern motivation practices by emphasizing psychological and behavioural factors that influence work behaviour. Maslow's theory posits that individuals are motivated to satisfy five levels of needs-physiological, safety, love/belonging, esteem, and self-actualization-sequentially (Maslow, 1943). In a workplace context, this implies that employers must ensure basic needs such as fair wages and job security before expecting peak performance and innovation from their workforce. Herzberg's Two-Factor Theory distinguishes between hygiene factors (e.g., salary, job security, work conditions) and motivators (e.g., achievement, recognition, personal growth) (Herzberg, Mausner & Snyderman, 1959). While hygiene factors prevent dissatisfaction, they do not motivate; true motivation comes from the intrinsic aspects of the job, indicating that job enrichment strategies are critical for employee engagement. McGregor's Theory X and Theory Y (1960) presents two contrasting managerial assumptions: Theory X assumes employees are inherently lazy and require control, whereas Theory Y assumes employees are self-motivated and seek responsibility. McGregor's model challenges organizations to rethink managerial styles and foster an environment of trust and autonomy (McGregor, 1960). Contemporary theories such as Vroom's Expectancy Theory (1964) and Deci & Ryan's Self-Determination Theory (1985) further enhance motivational understanding. Vroom suggests that motivation is a function of expectancy (effort leads to performance), instrumentality (performance leads to reward), and valence (value of reward) (Vroom, 1964). Self-Determination Theory emphasizes autonomy, competence, and relatedness as key drivers of intrinsic motivation (Deci & Ryan, 1985). These theories collectively inform strategic human resource practices, promoting intrinsic motivation over extrinsic incentives, and emphasizing the role of job design, leadership, and organizational culture. Understanding these foundational theories enables a comparative analysis of their applicability across diverse organizational contexts and workforce demographics.

Maslow's Hierarchy of Needs and Its Relevance to Workplace Productivity

Abraham Maslow's Hierarchy of Needs (1943) remains one of the most influential psychological theories for understanding human motivation, particularly within workplace contexts. The theory proposes that human needs are arranged in a five-tier model: physiological, safety, social, esteem, and self-actualization. According to Maslow, individuals must satisfy lower-level needs before progressing to higher levels of motivation and functioning. In the workplace, physiological needs, such as adequate salary, rest breaks, and comfortable working conditions, are foundational for employee productivity. Without these basic provisions, employees may be physically and mentally unfit to perform tasks effectively (Maslow, 1943). Safety needs, which include job security, safe work environments, and health benefits, are essential for reducing anxiety and enabling employees to focus on performance. Organizations that offer clear contracts, consistent policies, and a culture of

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026342

stability foster greater employee commitment and lower turnover (Robbins & Judge, 2019). At the social level, employees seek a sense of belonging through positive interpersonal relationships with colleagues and supervisors. Team-building initiatives, open communication, and inclusive workplace cultures significantly impact employee morale and cohesion (Armstrong & Taylor, 2020). Esteem needs involve recognition, respect, and achievement. Employers that provide meaningful feedback, promotion opportunities, and rewards systems enhance employees' self-worth, encouraging higher levels of output and innovation (Herzberg, 1968; Robbins & Judge, 2019). Finally, self-actualization, the highest level, pertains to the fulfillment of personal potential. In the workplace, this translates to opportunities for creativity, personal growth, and autonomy. Employees who reach this stage are often the most engaged and productive, as their work aligns with intrinsic interests and values (Deci & Ryan, 1985). Critically, Maslow's theory has been challenged for its rigid hierarchy and lack of empirical support. For instance, individuals may pursue higher needs without fully satisfying lower ones, particularly in collectivist cultures where social needs may outweigh individual goals (Hofstede, 1980). Nevertheless, the theory remains relevant for understanding motivation in stages and for designing holistic employee engagement strategies. Organizations that strategically align their HR policies with Maslow's framework are more likely to foster environments that support productivity, job satisfaction, and long-term organizational growth.

Herzberg's Two-Factor Theory and Employee Performance

Herzberg's Two-Factor Theory, developed by Frederick Herzberg and colleagues in the late 1950s, is a seminal framework that distinguishes between factors causing job satisfaction (motivators) and those causing job dissatisfaction (hygiene factors) (Herzberg, Mausner & Snyderman, 1959). According to the theory, these two sets of factors operate independently and have different effects on employee performance and workplace productivity. Hygiene factors include aspects such as salary, company policies, supervision, working conditions, job security, and interpersonal relations. These factors do not directly motivate employees or lead to higher productivity, but their absence causes dissatisfaction and disengagement (Herzberg et al., 1959). For instance, poor supervision, inadequate pay, or unsafe working conditions can demotivate employees, resulting in absenteeism, low morale, and reduced output. However, even when these conditions are optimal, they merely prevent dissatisfaction but do not actively motivate employees (Robbins & Judge, 2019).

In contrast, motivator factors, which include achievement, recognition, the work itself, responsibility, advancement, and personal growth, are intrinsic to the job and lead to higher levels of motivation, commitment, and productivity when present. These factors satisfy employees' higher psychological needs and are critical for job enrichment strategies. When employees feel that their work is meaningful and that they are being recognized for their contributions, their performance tends to improve significantly (Armstrong & Taylor, 2020). As a matter of fact, Herzberg's theory challenged the traditional view that salary alone is a sufficient motivator. Instead, it introduced the idea that motivation is driven more by the content of the work than by external rewards. However, the theory has also faced criticism. For example, it assumes a universal response to motivators and hygiene factors, overlooking individual and cultural differences in motivation (Hofstede, 1980). Additionally, the methodology, based on critical incident interviews, has been questioned for subjectivity and potential bias (Pinder, 2014). Despite its limitations, Herzberg's Two-Factor Theory remains a valuable tool for understanding employee motivation and designing effective workplace policies. Organizations that balance hygiene maintenance with intrinsic motivator enhancement are better positioned to boost employee engagement and performance, thus fostering a productive work environment.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026342

Self-Determination Theory: Autonomy, Competence, and Relatedness at Work

Self-Determination Theory (SDT), developed by Deci and Ryan (1985), offers a comprehensive framework for understanding intrinsic motivation in the workplace. Unlike extrinsic motivators such as monetary rewards or punishments, SDT emphasizes the importance of internal drives and the fulfillment of basic psychological needs-autonomy, competence, and relatedness-as essential conditions for optimal performance, engagement, and well-being at work. Autonomy refers to the feeling of volition and control over one's actions. Employees are more likely to be intrinsically motivated when they perceive that their decisions are self-endorsed rather than externally imposed (Deci & Ryan, 2000). In organizational settings, autonomy-supportive leadership, flexible schedules, and participative decision-making have been linked to higher job satisfaction, creativity, and productivity (Gagné & Deci, 2005). Competence involves the need to feel effective in one's role and capable of achieving desired outcomes. When employees are provided with challenging but attainable tasks, constructive feedback, and opportunities for skill development, they experience a sense of mastery, which enhances their intrinsic motivation and job performance (Van den Broeck et al., 2016). Conversely, lack of opportunities for growth or excessive control can stifle competence and lead to disengagement. Relatedness is the need to feel connected to others and experience a sense of belonging. A workplace culture that encourages collaboration, mutual respect, and supportive interpersonal relationships fulfils this need and contributes to emotional well-being and organizational commitment (Baard, Deci & Ryan, 2004). Critically, SDT contrasts with traditional motivation theories that rely heavily on extrinsic incentives. Research indicates that excessive use of external rewards can undermine intrinsic motivation, particularly when they are perceived as controlling (Deci, Koestner & Ryan, 1999). However, a balance between extrinsic and intrinsic motivators may be necessary in certain job contexts, particularly in routine or low-autonomy roles. SDT has been empirically validated across cultures and industries, reinforcing its relevance to contemporary human resource practices. By fostering autonomy, competence, and relatedness, organizations can cultivate a motivated workforce, enhance performance outcomes, and promote sustainable employee engagement.

Comparative Analysis of the Three Theories: Maslow's Hierarchy of Needs, Herzberg's Two-Factor Theory, and Self-Determination Theory

Understanding workplace motivation is fundamental to enhancing employee performance and organizational effectiveness. Maslow's Hierarchy of Needs (1943), Herzberg's Two-Factor Theory (1959), and Self-Determination Theory (SDT) by Deci and Ryan (1985) offer distinctive yet complementary perspectives. A comparative analysis of these theories in terms of assumptions, applicability, and effectiveness provides deeper insight into their practical value and theoretical robustness.

Assumptions

Maslow's theory assumes a linear progression of needs from basic physiological requirements to self-actualization (Maslow, 1943). The model posits that once a lower need is satisfied, it ceases to motivate, and the individual moves to higher-level needs. In contrast, Herzberg's Two-Factor Theory distinguishes between hygiene factors (extrinsic) that prevent dissatisfaction and motivators (intrinsic) that promote satisfaction and productivity (Herzberg, Mausner & Snyderman, 1959). This theory assumes that satisfaction and dissatisfaction are not on the same continuum. Self-Determination Theory (SDT), meanwhile, is grounded in humanistic psychology and assumes that

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026342

individuals are inherently driven by a need for autonomy, competence, and relatedness (Deci & Ryan, 1985). Unlike Maslow's fixed hierarchy or Herzberg's dichotomy, SDT assumes that all three psychological needs are equally vital and continuously influence motivation.

Applicability

Maslow's theory has broad appeal due to its simplicity and intuitive logic. It is often used in designing employee reward systems and job enrichment programmes. However, its hierarchical structure lacks empirical support and does not account for cultural or individual variability (Hofstede, 1980). Herzberg's model is more specific to the workplace and has informed practices such as job enrichment and redesign, making it practically applicable in organizational settings. SDT is widely applicable across diverse contexts, from corporate settings to educational and healthcare environments. Its emphasis on intrinsic motivation aligns well with contemporary organizational values like employee empowerment, well-being, and autonomy. Moreover, SDT's principles are supported by robust empirical studies and are adaptable across cultures (Gagné & Deci, 2005; Van den Broeck et al., 2016).

Effectiveness

In terms of effectiveness, Maslow's theory is more descriptive than prescriptive and lacks empirical precision. Herzberg's theory has had a significant influence on HR practices but has been criticized for methodological limitations, such as relying on critical incident techniques that may introduce bias (Pinder, 2014). Nonetheless, its distinction between hygiene and motivator factors remains useful in understanding dual aspects of job satisfaction. SDT is arguably the most empirically validated of the three. It provides a dynamic and integrative model of motivation, highlighting how supportive work environments foster sustained engagement and performance. It also accommodates both intrinsic and extrinsic motivations, offering a more nuanced understanding of human behaviour (Deci & Ryan, 2000). While each theory has its limitations, their integration offers a comprehensive view of workplace motivation. Maslow's model outlines the progressive nature of needs, Herzberg focuses on job content versus context, and SDT emphasizes the fulfillment of psychological needs. Organizations can draw from all three to design holistic motivational strategies that cater to diverse employee expectations and workplace dynamics.

Application of Motivation Theories in Organizational Settings

The practical application of motivation theories in organizational settings has proven essential in driving employee performance, enhancing job satisfaction, and fostering a productive workforce. Organizations globally have adapted theories such as Maslow's Hierarchy of Needs, Herzberg's Two-Factor Theory, and Self-Determination Theory (SDT) to design policies and practices that enhance motivation and workplace outcomes. Maslow's Hierarchy of Needs has been widely applied in structuring employee reward systems. For example, Google addresses Maslow's needs by offering competitive salaries (physiological needs), job security (safety needs), a collaborative culture (belongingness), peer recognition (esteem), and opportunities for innovation (self-actualization) (Robbins & Judge, 2019). While the hierarchy may not always follow a strict progression, its framework helps managers identify where an employee may need support to enhance engagement. Herzberg's Two-Factor Theory has been utilized to improve job design and satisfaction. The Ritz-Carlton Hotel Company, for instance, emphasizes both hygiene factors, such as quality working conditions and job security, and motivators, such as recognition, career development, and empowering employees to make decisions (Herzberg et al., 1959; Armstrong & Taylor, 2020). By separating the causes of dissatisfaction from satisfaction, management effectively enhances both retention and service excellence. Self-Determination Theory has been adopted in modern, autonomy-focused organizations. Atlassian, a software company, applies SDT by granting employees "20% time"

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026342

to work on passion projects, promoting autonomy, and hosting regular feedback and mentorship sessions to foster competence and relatedness (Deci & Ryan, 2000; Gagné & Deci, 2005). These practices have reportedly led to increased innovation and employee satisfaction. Critically, successful application of these theories requires contextual adaptation. For instance, while autonomy may motivate in creative sectors, structured environments may benefit more from fulfilling security and belonging needs. Thus, tailoring motivational strategies to specific organizational cultures and employee expectations is essential for effectiveness.

Implications for Nigerian Workplaces

Applying motivation theories in the Nigerian workplace context requires a nuanced understanding of the country's unique socio-cultural and economic environment. Factors such as high unemployment rates, income inequality, limited job security, and cultural collectivism significantly shape how motivational strategies are perceived and implemented. Maslow's Hierarchy of Needs, for instance, has limited sequential applicability in Nigeria due to widespread economic instability. Many employees are preoccupied with satisfying lower-tier needs such as job security and basic remuneration (Eze, 2015). Hence, expecting self-actualization without addressing these foundational concerns is unrealistic. Employers must prioritize competitive wages, healthcare benefits, and safe working conditions to foster loyalty and productivity. Herzberg's Two-Factor Theory is particularly relevant in Nigeria's public and private sectors. While hygiene factors such as salary and working conditions are often insufficient or inconsistent, they remain critical in preventing job dissatisfaction. A study by Okpara (2004) on job satisfaction among Nigerian managers found that poor organizational policies and lack of recognition were significant sources of dissatisfaction. Incorporating motivators, such as advancement opportunities, recognition, and meaningful work, can help organizations boost intrinsic motivation and reduce employee turnover. Self-Determination Theory (SDT) also offers valuable insight, especially in empowering employees through autonomy and skill development. However, Nigeria's high power-distance culture (Hofstede, 1980) may limit the effectiveness of autonomy-driven strategies unless leadership styles evolve to be more participatory. Organizations such as Dangote Group have successfully promoted competence and relatedness by investing in employee training and promoting team-based culture (Adeleye et al., 2014). Thus, for motivation theories to yield desired results in Nigeria, they must be adapted to local realities. Emphasis should be placed on improving working conditions, aligning incentives with employee needs, and fostering inclusive workplace cultures.

Conclusion

This study has critically examined key motivation theories-Maslow's Hierarchy of Needs, Herzberg's Two-Factor Theory, and Self-Determination Theory-and their relevance to workplace productivity. Each theory offers unique insights into how intrinsic and extrinsic factors influence employee behaviour and performance. Their application in organizational settings, particularly within the Nigerian context, highlights the importance of aligning motivational strategies with socio-cultural and economic realities. Ultimately, organizations that prioritize employee needs, create enabling environments, and adapt motivation models to local contexts are more likely to experience enhanced productivity, job satisfaction, and workforce retention. A dynamic, context-sensitive approach to motivation remains crucial for sustainable organizational growth and development.

Recommendations

Improving workplace productivity requires a strategic application of motivation theories tailored to organizational and cultural contexts. Drawing from Maslow's Hierarchy of Needs, Herzberg's Two-

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026342

Factor Theory, and Self-Determination Theory, the following recommendations offer actionable steps to enhance employee performance and engagement:

1. Align Motivation Strategies with Employee Needs: Organizations should tailor motivational approaches to reflect the specific needs of their workforce. As Maslow (1943) emphasized, employees are only motivated to pursue higher-level goals when their basic needs are met. Nigerian firms should first ensure competitive compensation and job security to create a foundation for higher productivity.
2. Balance Hygiene and Motivator Factors: Following Herzberg's (1959) Two-Factor Theory, employers should address both extrinsic (e.g., salary, job conditions) and intrinsic (e.g., recognition, achievement) motivators. Offering career growth opportunities and recognizing achievements can reduce dissatisfaction and enhance engagement.
3. Foster Autonomy, Competence, and Relatedness: As proposed by Deci and Ryan (2000) in Self-Determination Theory, creating an environment where employees feel autonomous, competent, and connected promotes sustained motivation. Encouraging participatory decision-making and professional development can foster these psychological needs.
4. Contextualize Motivation for Nigerian Workplaces: Given Nigeria's socio-economic realities, motivational strategies must consider cultural values like collectivism and high-power distance (Hofstede, 1980). Organizations should promote teamwork, mentorship, and respect for hierarchical structures while gradually empowering employees through inclusive leadership.

References

Adeleye, I., Adegbite, E., & Akinbinu, B. (2014). Human resource strategies in emerging economies: The Nigerian experience. *Journal of Developing Areas, 48*(3), 179–199.

Armstrong, M., & Taylor, S. (2020). *Armstrong's handbook of human resource management practice* (15th ed.). Kogan Page.

Baard, P. P., Deci, E. L., & Ryan, R. M. (2004). Intrinsic need satisfaction: A motivational basis of performance and well-being in two work settings. *Journal of Applied Social Psychology, 34*(10), 2045–2068.

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*(4), 227–268.

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin, 125*(6), 627–668.

Drucker, P. F. (1999). *Management challenges for the 21st century*. Harper Business.

Eze, F. U. (2015). Motivation and job satisfaction: A study of the Nigerian banking sector. *European Journal of Business and Management, 7*(14), 23–30.

Gagné, M., & Deci, E. L. (2005). Self-determination theory and work motivation. *Journal of Organizational Behaviour, 26*(4), 331–362.

Herzberg, F. (1968). *Work and the nature of man*. World Publishing Company.

Herzberg, F., Mausner, B., & Snyderman, B. B. (1959). *The motivation to work*. Wiley.

Hofstede, G. (1980). *Culture's consequences: International differences in work-related values*. Sage Publications.

Maslow, A. H. (1943). A theory of human motivation. *Psychological Review, 50*(4), 370–396.

McGregor, D. (1960). *The human side of enterprise*. McGraw-Hill.

Okpara, J. O. (2004). Job satisfaction and organizational commitment: Are there differences between American and Nigerian managers? *Academy of Business & Administrative Sciences, 3*(1), 1–17.

Pinder, C. C. (2014). *Work motivation in organizational behavior* (2nd ed.). Psychology Press.

Robbins, S. P., & Judge, T. A. (2019). *Organizational behavior* (18th ed.). Pearson.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026342

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*(1), 54–67.

Van den Broeck, A., Ferris, D. L., Chang, C. H., & Rosen, C. C. (2016). A review of self-determination theory's basic psychological needs at work. *Journal of Management, 42*(5), 1195–1229.

Vroom, V. H. (1964). *Work and motivation.* Wiley.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026343

Assessment Of Water Sanitation and Hygiene Practice Among Citizens In Mubi North Local Government Area Of Adamawa State, Nigeria

ISHAKU, Ruth
Email: ruthishaku49@gmail.com
Phone number +234- 8038165684

Department of Economics, Adamawa State University Mubi, Adamawa State, Nigeria

Abstract

A survey design study was conducted to check the functionality of Water Sanitation and Hygiene Practice (WASH) implemented by Non-governmental organization (NGOs) in Mubi North LGA, Adamawa state. The study adopts a descriptive survey design. The target population consist of all secondary school principal, primary health centre, community head (Jauro) and educated house hold (women) in the area. A stratified random sample technique was used in the study. A structured questionnaire using Likert scale was used for the purpose of data collection. Data collected from the field of study were subjected to statistical package called statistic 8.0, where it was analyzed and presented in tables using simple percentage and mean to answer research question. Result from the study on health facility reveals that the sustainability of WASH facilities is heavily dictated by institutional budget constraints and patient poverty. it was concluded that, the sustainability of sanitation and hygiene projects is directly tied to community involvement; house hold and good funding from donors or governments. It was recommended that members of the community should participate in the process of sustaining water and sanitation infrastructure. There is need to encourage women to improve their economic sources of living. Non-governmental organization should have a strong feedback mechanism on each WASH projects in the community, community members especially women should be educated on village loan saving association to support their personnel hygiene practices at home.

Keys words; Sustainability, WASH, Women, Community

Introduction

Safe water and sanitation are essential not only for health and well-being but also for their impact on everyday life. Water used for drinking, irrigation, bathing, and various household purposes can become contaminated, and consumption of contaminated or unsafe water results in poor health outcomes, such as diarrhea, neglected tropical diseases (NTDs), and even death (World Health Organization [WHO] 2022a). Therefore, having access to improved water sources and sanitation facilities is considered a right that is fundamental to enjoying other human rights (Armah et al. 2018; Kayser et al. 2019). According to WHO (2022b), an improved water source is one that is protected from outside contamination, especially from fecal matter, while an unimproved water source is not protected from outside contamination. An improved sanitation facility is one that hygienically separates excreta from human contact while an unimproved sanitation facility does not offer this protection (WHO 2022b). Household water, sanitation, and hygiene (WASH) sources have been shown to have crucial socioeconomic development and health implications. In low-income or developing countries, most water-borne diseases have been associated with drinking unsafe water. In Africa, more than 2,000 people die every day from illnesses that are related to poor sanitation and hygiene, and drinking unsafe water (Abubakar 2019). Limited access to safe drinking water and improved sanitation facilities, as well as improper or lack of water treatment practices, can promote the spread of water-borne diseases (Omole & Ndambuki 2014; Prüss-Üstün et al. 2018). There is a high concern for the sustainability of water, sanitation, and hygiene (WASH) services, such as provision of water supply and sanitation services, in community. Sustainability in the WASH services means that the WASH services remain functional, even after the WASH implemented organization leaves that place (Cross P., *et al* 2016). Study conducted by Joseph G., *et al* 2019 mentioned that many WASH services

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026343

failed, especially in rural areas, where water supply or sanitation services are implemented, because of this a lot of investment are wasted due to this problem. For example, it was estimated that the WASH system failure in Africa resulted in a lost investment of $1.2 billion (Bonsor *et al* 2001). He furthermore mentioned unsustainable WASH services inhibit the progress of the UN Sustainable Development Goals 6 that is, achieving 100% access to safely managed water and sanitation services. Accesses to sustainable water, sanitation and hygiene (WASH) practices remain critical challenges in Mubi North, where a socio-economic factor heavily influences intervention out comes. Many women in Mubi have been educated on sanitation hygiene practices, most of them couldn't sustained this hygiene practices, they face barriers to sustained these practices due to poverty which undermine long term WASH sustainability in both house hold and communities

Literature Review

The issues affecting sustainability of water sanitation hygiene practices has been richly discussed by diverse theoretical frameworks contributing to nuanced understanding intricate discussion. (Adams *et al.* 2016; Emenike *et al.* 2017; Abubakar 2019; Rodriguez 2019), reported that socioeconomic factors, such as poverty, education, and residence type (urban or rural), have important implications for longevity of safe water, sanitation and health behavior. In a secondary data analysis of the 2008 Ghanaian Demographic and Health Surveys (GDHS), Adams *et al.* (2016) found that poverty level, education level, and region / type of residence were among significant predictors of sustainability to an improved drinking water source. In another study conducted by Irianti *et al.* (2016) using 2007 Indonesian family life survey data, the researchers found education, wealth, toilet type, and place of residence to be among significant determinants of household drinking water sources in Indonesia. A study conducted by Action (2019) focused on rural settlements in parts of southwest Nigeria found that the majority of the households of which most were low-income– relied on unimproved water sources and sanitation facilities. Emenike *et al.* (2017)'s study on southwest Nigeria reported that increased income was correlated with access to improved water sources. Similarly, Rotowa *et al.* (2015) in Akure, a city in southwestern Nigeria, mentioned that Nigerians who earned higher income used improved sanitation facilities and that Nigerians in community whose education level was below tertiary education used unimproved sanitation facilities.

Concepts of WASH Sustainability in Community

The concept of sustainability gained ground in the 1980s when environmental degradation and pollution was at its highest globally and defining sustainability and development has been difficult. Project intervention sustainability is recognized as a key factor to be considered in donor funded projects. According to Harvey and Hurworth (2017), project sustainability refers to a project's ability to continue serving the community or stakeholders for an extended period of time. Furthermore, they describe sustainability as a company's capacity to build a growth strategy and advancement that works indefinitely (Ochelle, 2020). A study by Foxand (2017) investigated the long-term viability of projects in rural parts of South Africa's Limpopo Province. Form his study it was discovered that projects could not be performed and sustained without the active engagement of the community. He further buttress many projects fail, leaving populations in a state of abject poverty due to poor sustainability. Another study on the survival rate of community-based projects in South Africa conducted by Korten (2020) found that lack of relevant skills, poor finances and education to manage projects has a negative impact on most project sustainability because project managers and their teams make mistakes and blunders that impede project sustainability. Research by Muttagi (2017) found that the failure of many donor-funded projects in developing nations may be traced back to ineffective administration of grassroots efforts. Many donor-funded initiatives in developing countries

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026343

have failed because of poor administration of community projects. This research seek to unveil where many community member fail to have access to clean water, poor sanitation practices in primary health care and many unused toilets in our secondary schools despite WASH intervention by NGOs in Mubi North

Statements of the Problem

Numerous WASH projects like toilets, in secondary school, boreholes, women education on hygiene practices have been implemented in Mubi North by several International Non-Governmental organization and local Non-Governmental organization in Mubi North, and their long term sustainability is undermine by socioeconomic determinant, such as house income among women, education levy in secondary school, poor funding of secondary school by government. These factors result in low functionality rate of toilets in secondary schools, poor hygiene practice among women, and poor WASH facilities in primary health center. Purdum, (2002) mentioned that, despite attempts to enhance community WASH practices in communities, long term sustainability remains a concern. Most of these projects implemented by Non-Governmental Organization water, sanitation and hygiene programs fail within three years after inception that why this study seeks to unveil factors contributing poor management practices of WASH in Mubi LGA.

Theoretical Framework

The legitimacy theory as developed by Woodward (1995) states that there should be congruence between the expectations of the local community and the value addition to be achieved from a project. This implies that legitimacy is a value system derived from the existence of a project within the community which makes it acceptable. This also means that the perceptions of key stakeholders about the existence, impact and activities of the project are justifiable and appropriate to the community and the government institutions. This theory is supported by Brown (2017), arguing that legitimacy is determined by the project organization's perceptions of its social contract within society. It has to do with the legal, acceptable, and defensible right to be and do anything in a community. In their chosen path of action, organizations must fulfill a social compact within society in a way that is legitimate, acceptable, and justifiable. This theory will be beneficial in this research since it will aid in the development of a clear understanding of the legality, admissibility and justification of the sanitation and hygiene projects. Sustainability of the projects in Mubi will depend on whether they are acceptable to the local communities and comply with the legal and environmental requirements of the country national governments.

Objective of the Study

The objective of the study is to Assess Water sanitation and Hygiene (WASH) intervention among citizens in Mubi North Local Government Area of Adamawa state. Specifically, to identify socioeconomic determinant influencing the sustainability of WASH intervention in Mubi North LGA

Methodology

Research Design

The study adopts a descriptive survey design. According to Cooper and Schindler (2014), this strategy is used when the researcher is interested in determining who, what, where, when, or how much information is being gathered. According to Orodho (2018), descriptive survey design is ideal since it is used to gather data that portrays contemporary occurrences by asking individuals questions about their views, attitudes, actions, or values. It is also useful for describing or investigating the current condition of two or more variables. Because they are objective, this design was helpful in describing and measuring the elements that affect the sustainability of the sanitation and hygiene initiatives by Non- governmental Organizations has completed in Mubi North.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026343

Target Population

According to Cooper and Schindler (2017), population refers to the entire collection of goods or subjects that a researcher is interested in. Populations could be defined by Kothari (2017) as the universe or complete set of humans, things, or stuff that has common observable traits and hold the correct information that the researcher is looking for. The target population consisted of five secondary school principal, ten primary health centre officer, five community head (Jauro) and ten educated house hold (women) on WASH by NGOs in Mubi North. In each selected ward. Mubi has eleven wards and seven ward were selected where WASH facilities in health care centre, secondary schools, and women that has undergo training on WASH practices.

Sample Size and Sampling Procedures

According to Creswell (2016), a sampling frame refers to the actual occurrences or persons from which a sample was drawn to represent the total population. The sampling frame for this study included five secondary school principal, community heads; ten health officer ten houses hold women who have undergone intervention in each ward. A stratified random sample technique was used in the study. This is due to the research population's heterogeneity, which principal officers was obtained from each unit, and the sub-categories were connected to provide full stratified samples as provided by Yamane (1967). According to Creswell (2016), a sampling frame refers to the actual occurrences or persons from which a sample was drawn to represent the total population. The sampling frame for this study included two secondary school principal, two community head, two health officer and two houses hold women who has undergone intervention per ward. A stratified random sample technique was used in the study. This is due to the research population's heterogeneity, which principal officers was obtained from each unit, and the sub-categories were connected to provide full stratified samples as provided by Yamane (1967).

The sample size of the study was 180 respondents using Yamane's formula

Table 1: Sample Procedure of Respondent

Wards	School Principal	Health Officers	Community Leaders	Train Women on WASH Practice	Total
Yelwa	5	10	5	10	30
Muchala	5	3	5	10	23
Vintim	5	7	5	10	27
Bahuli	5	7	5	10	27
Sabon layi	5	10	5	15	35
Muchalla	3	3	3	10	19
Mijulu	3	3	3	10	19
Total					180

Data Collection Procedure

A structured questionnaire using Likart scale was used for the purpose of data collection. The researcher was in a position to gather data of both a quantitative and a qualitative nature from the respondent. The goal of a questionnaire, according to Alshenqeeti (2014), is to ensure that the data acquired accurately reflects the respondents' thoughts and sentiments. The major goal of employing questionnaires in this study was to guarantee that all of the respondents are given the same questions, reducing interviewer effect and other anomalies.

Validity of Research Instrument

According to Kothari (2017), the effectiveness or accuracy with which a research instrument evaluates the notion or variable that it is supposed to test run is known as validity. The content validity of the instrument was established in this study by pilot-testing it on ten randomly selected health workers, two community head, and two principal officers in Mubi North, The ten randomly

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026343

selected individuals were not involved in the final study to avoid biasness since they had been exposed to the instrument. The researcher then revised the instrument to ensure that it has all of the information and addresses the study's objectives.

Data Analysis

Data collected from the field of study were subjected to statistical package called statistic 8.0, where it was analyzed and presented in tables using simple percentage and mean to answer research question.

Presentation of Results

This comprehensive analysis explores the socio-economic factors influencing the sustainability of Water, Sanitation, and Hygiene (WASH) practices and facilities in Mubi North. Based on the data regarding school-based presented on table1. WASH facilities indicates a significant majority of respondents (89.3 %) agree that a lack of dedicated school funding is the primary barrier preventing regular toilet maintenance, this financial strain is compounded by the economic status of the community. 93.9 % of participants believe that parents low-income levels strictly limit their ability to contribute essential supplies such as soap and hand sanitizer. Consequently, 89.3 % of the surveyed population observes that toilets break down frequently due to a lack of repair funds. A critical trend identified is the post-intervention gap, where 81.2 % of respondents feel that once NGOs or government bodies complete the initial installation, there is a total cessation of supply chains for toiletries. Ultimately, 87.4 % of respondents conclude that poor school revenue has a direct, negative effect on the long-term sustainability of these facilities.

Table 1: Factors Influencing the Sustainability of WASH Practices Maintenances due to Economic Factor in Mubi North LGA

SN	Variables	Mean	SD	SA %	Agree %	S %	D. %
1	Lack of school funding prevent regular toilet maintenance	1.38	1.48	61.5	89.3	19.2	10
2	Parent's low-income limits contributions for toilets supplies (soap, sanitizer etc.).	1.78	1.37	93.9	63.3	10.3	13.6
3	Toilets break down often due to poor funding for repairs	1.54	1.89	89.3	56.9	81.3	12.8
4	Since intervention by NGOs / governments no one care to supply toiletries	1.66	1.82	72.3	81.2	14.7	11.8
5	School poor revenue has effects on toilet maintenances	1.47	1.87	68.8	87.4	11.0	10.8
6	**Cluster Mean**				1.68		

Sources: Field Survey 2025

Result presented on table 2 in the context of healthcare, reveal that the sustainability of WASH facilities is heavily dictated by institutional budget constraints and patients' poverty. Approximately 85.6 % of the data suggests that limited budgets allocated to Primary Health Care centers result in unreliable water and sanitation services. The hygiene environment is further compromised by the financial status of the users, 89.4% of respondents agree that patients cannot afford to provide their

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026343

own soap or sanitizer, which leads to worsening hygiene conditions within the clinics. Delays in repairs are almost universally attributed to a lack of government funding (87.5%). Furthermore, 72.87 % of respondents believe that general community poverty reduces overall compliance with WASH standards. These factors culminate in a significant waste of infrastructure, as 70.7 % of participants report that many WASH facilities remain unused simply because they have fallen into disrepair due to poor maintenance.

Table 2: Factors Influencing the Sustainability of WASH Facilities in Primary Health Care in Mubi North

SN	Variables	Mean	SD	SA %	A %	SD %	D %
1	Limited budget to primary health care causes unreliable water / sanitation Centre	1.97	0.7	63.3	85.6	17.3	13.8
2	Patients can't afford soap / sanitizer, worsening hygiene in primary health care	1.62	0.52	89.4	74.7	11.8	4.1
3	Lack of government funding delay WASH repair	1.83	1.63	87.5	85.1	4.6	2.8
4	Poverty in community reduces WASH compliances	1.43	0.49	72.7	70.1	19.2	18.0
5	Most WASH facilities are not in used due to poor maintenance	1.54	0.50	70.7	64.1	19.2	26.0
	Cluster Mean	**1.66**					

Sources: Field Survey 2025

Results presented on table 3 reveal reveals a stark divide between hygiene knowledge and financial capability among women in Mubi North, while training programs appear to be well-received, 72.2 % of women stated that they cannot afford the supplies recommended during those sessions. Poverty is cited by 76.9 % of respondents as the direct reason they cannot maintain home toilets or latrines. Specifically, 65.8 % of women lack the funds to purchase basic sanitizers for their families, and 78.5 % confirm that family income is the ultimate limiting factor in their ability to sustain hygiene practices. The data suggests that modern hygiene practices are perceived as a luxury, with 78.9 % of respondents agreeing that these standards are simply too expensive for the average household to maintain.

Table 3: Factors Influencing the Sustainability of WASH Practices among Women in Mubi North

SN	Variables	Mean	SD	SA%	A%	SD %	D %
1	I lack money to buy sanitizer for home WASH practices in my family	1.72	0.50	72.2	48.6	34.6	20.6
2	Poverty prevents me from maintaining home toilets / latrines WASH practices	2.01	1.23	76.9	60.9	20.1	22.1
3	Training was good but I can't afford recommended supplies	1.94	1.23	60.5	65.8	22.3	31.4

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026343

4	Family income limits my abilities to sustain WASH	1.50	0.63	76.9	78.5	42.8	1.8
5	Modern hygiene practices among women are expensive I can afford	1.59	0.78	78.9	40.4	20.8	30.9
	Cluster Mean	**1.72**					

Sources: Field Survey 2025 / 2026

Results presented on table 4 shows the functionality of public water points, where the data shows a breakdown in the community-funded maintenance model. Roughly 74.4 % of respondents state that their boreholes are currently non-functional because of a lack of financial support for maintenance. Although user fees are a common strategy for sustainability, 70.7% of the community agrees that widespread poverty prevents the collection of these fees for repairs. This creates a dependency on external aid. 70.3 % of respondents admit that once donor or government funding ceases, the community is unable to repair the borehole after a breakdown. There is also a notable issue with resource management, as 77.6 % agree that low-income households tend to overuse the borehole without contributing to its upkeep. Interestingly, 70.2 % of the data suggests that the mere presence of a borehole sometimes discourages community members from contributing, as they may take the access for granted until the facility fails completely.

Table 4: Factors Influencing the Sustainability of Water Borehole in Mubi North after Intervention by NGOs/ Government

SN	Variables	Mean	SD	SA%	A%	SD%	D%
1	Our bore hole are not functioning due to lack of financials support for maintenances	1.77	068	74.4	73.9	19.3	20.4
2	Community poverty prevent user fees for bore hole repairs	1.72	0.76	54.3	70.7	44.1	10.9
3	Since break down of borehole because of lack fund from donor and government, we couldn't repair borehole	1.55	0.71	56.9	70.3	19.6	24.3
4	Low-income house over use borehole without contributing	1.69	0.58	69.48	77.6	20.12	12.8
5	Access to borehole discourage community member from contributing	1.42	0.58	57.4	70.2	21.1	29.3
6	**Cluster Mean**			**1.52**			

Sources: Field Survey 2025

Discussion of Findings

The objective of this study was to assess the Socio-Economic Determinant of the sustainability of WASH intervention among women household, schools, health centre and community participation in sustainability of sanitation and hygiene projects implemented by NGOS, the study found out that there was a positive and significant relationship between the keys factors participation and sustainability of sanitation and hygiene projects. The study found that all the four variables play a significant role in sustaining WASH projects. These results are in line with those of Odhiambo (2020), who argues that community support for a project guarantees its success by empowering previously marginalized groups and movements to enhance their influence and control over the project's resources and governing structures. According to Orodho (2017) community participation in project planning like WASH and implementation ensures project ownership and contributed to long term

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026343

viability of community-based. The study is also in line with the finding of Foxand (2017) who reported that long-term viability of projects in rural parts of South Africa's Limpopo Province that has to do with WASH intervention, form his study it was discovered that WASH projects could not be performed and sustained without the active engagement of the community. He further buttresses many projects fail, leaving populations in a state of abject poverty due to poor sustainability. Another study on the survival rate of community-based projects in South Africa conducted by Korten (2020) found that lack of relevant skills, poor finances and education to manage projects has a negative impact on most project sustainability because project managers and their teams make mistakes and blunders that impede project sustainability. A Research by Muttagi (2017) found that the failure of many donor-funded projects in developing nations may be traced back to ineffective administration of grassroots efforts. Many donor-funded initiatives in developing countries have failed because of poor administration of community projects

Conclusion

The research findings suggest that the success of sanitation and hygiene projects could only be sustained when government and community members that are well to do support the projects after implementation. The sustainability of sanitation and hygiene projects is directly tied to community involvement; house old and good funding from donors or governments. Further, the study found that parents who had students in secondary school had an effect on the sustainability of sanitation and hygiene projects implemented in their varicose school. This confirmed by the majority of respondents who strongly agree that lack of school fees affected the sustainability of sanitation and hygiene projects. Therefore, this study concluded that there was a positive and significant effect on the sustainability of sanitation and hygiene projects implemented by NGOS in Mubi North

Recommendation

Based on the findings it is therefore, recommended that

1. All members of the community should participate in the process of sustaining water and sanitation infrastructure.
2. There is need to encourage women to improve their economic sources of living.
3. Non-governmental organization should have a strong feedback mechanism on each WASH projects in the community.
4. community members especially women should be educated on village loan saving association to support their personnel hygiene practices at home.

References

Abubakar, I. R. 2019 Factors influencing household access to drinking water in Nigeria. Utilities Policy 58,40–51. https://doi.org/10.1016/ j.jup.2019.03.005.

Adams, E. A., Boateng, G. O. & Amoyaw, J. A. 2016 Socioeconomic and demographic predictors of potable water and sanitation access in Ghana. Social Indicators Research 126 (2), 673–687. https://doi.org/10.1007/s11205-015-0912-y.

Bonsor, H.C.; Oates, N.; Chilton, P.J.; Carter, R.C.; Casey, V.; MacDonald, A.M.; Calow, R.; Alowo, R.; Wilson, P.; Tumutungire, M.; et al. A Hidden Crisis: Strengthening the Evidence Base on the Sustainability of Rural Groundwater Supplies: Results from a Pilot Study in Uganda. 2015. Available online: http://nora.nerc.ac.uk/511071/1/HiddenCrisisFinalReportv7_bgsreview2%5Bces%5D.pdf (accessed on 21 December 2020).

Cooper, D. & Schindler, P. (2017) Business Research Methods (8th edn) McGraw-Hill: New York Creswell, J. W. (2017). Research Design: Qualitative, quantitative and mixed method approaches. Thousand Oaks, California: Sage Publications.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026343

Cross, P.; Coombes, W.Y.; Norman, R.; Nyarko, K.; Taher, M. Validation of Dutch Wash Alliance Track Record; Wash Alliance International: Haarlem, The Netherlands, 2016.

Emenike, C. P., Tenebe, I. T., Omole, D. O., Ngene, B. U., Oniemayin, B. I., Maxwell, O. & Onoka, B. I. 2017 Accessing safe drinking water in sub-Saharan Africa: Issues and challenges in south–west Nigeria. Sustainable Cities and Society 30, 263–272. https://doi.org/10.1016/ j.scs.2017.01.005.

Foxand (2017): The First National Communication of Kenya to the Conference of the Parties to the United Nations Framework Convention on Climate Change.

Irianti, S., Prasetyoputra, P. & Sasimartoyo, T. P. 2016 Determinants of household drinking-water source in Indonesia: An analysis of the 2007 Indonesian family life survey. Cogent Medicine 3 (1), 1151143. https://doi.org/10.1080/2331205X.2016.1151143. ISS African Futures 2023 5 Health and WaSH. https://futures.issafrica.org/thematic/05-health-and-wash

Korten (2020). Administration of Development Initiatives by NGOs: A Study of their Sustainability in Bangladesh and Nepal. Pp 1-88.

Mulenga, J. N., Bwalya, B. B. & Kaliba-Chishimba, K. 2017 Determinants and inequalities in access to improved water sources and sanitation among the Zambian households. 17, 746–762.

Ochelle, L., & Hampshire, J. (2020), Promoting Practical Sustainability, Quality Assurance Group. The Australian Agency for International Development. AUSAID government publications.

Omole, D. O. &Ndambuki, J. M. 2014 Sustainable living in Africa: Case of water, sanitation, air pollution and energy. Sustainability 6 (8), 8. https://doi.org/10.3390/su6085187. Prüss-Üstün, A., Bos, R., Gore, F. & Bartram, J. 2018 Safe Water, Better Health: Costs, Benefits and Sustainability of Interventions to Protect and Promote Health. World Health Organization, Geneva. https://apps.who.int/iris/handle/10665/43840

Orodho, J. A. (2018). Elements of Education and Social Science Research Methods (2nd ed.). Maseno, Kenya: Kanezja Publishers

Rodriguez, L. 2019 4 Factors Driving the Water & Sanitation Crisis in Africa. https://www.globalcitizen.org/en/content/water-and-sanitation crisis-sub-saharan-africa/ Rotowa, O. O., Olujimi, J., Omole, K. & Olajuyigbe, A. E. 2015 Socioeconomic Factors Affecting Household's Sanitation Preferences in Akure, Nigeria. https://www.semanticscholar.org/paper/Socioeconomic-Factors-Affecting-Household-%E2%80%99-s-in-%2C-OmoleF Olajuyigbe/5addee9a4e0dbb4a61fcd2bf7bbb694a6814ae42

Rotowa, O. O., Olujimi, J., Omole, K. & Olajuyigbe, A. E. 2015 Socioeconomic Factors Affecting Household's Sanitation Preferences in Akure, Nigeria. https://www.semanticscholar.org/paper/Socioeconomic-Factors-Affecting-Household-%E2%80%99-s-in-%2C-OmoleF lajuyigbe/5addee9a4e0dbb4a61fcd2bf7bbb694a6814ae42

Yamane (1967) Statistics, An Introductory Analysis, 2nd Ed., New York: Harper and Row.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026344

Qualitative Study on Impact of EfficientNet-Based Deep Transfer Learning Model for Pneumonia Detection with Explainable Artificial Intelligence using Chest Radiographs

USMAN, Opeyemi Lateef[1]
usmanol@tasued.edu.ng
+2348031910783

ADEUSI, Oluwasegun Opeoluwa[2]
adeusioo@tasce.edu.ng
+2347033364004

KAREEM, Morufat Adebola[1]
kareemma@tasued.edu.ng
+2348063678722

OWOADE, Akeem Ayoade[1]
owoadeaa@tasued.edu.ng
+2347036226048

MUNIYANDI, Ravie Chandren[3]
Ravie.chandren@uniten.edu.my
+60123249577

[1]Department of Computer and Information Science, Tai Solarin Federal University of Education, Ijagun, Ogun State, Nigeria.
[2]Department of Computer Science, Sikiru Adetona College of Education, Science and Technology, Omu-Ajose, Ogun State, Nigeria.
[3]College of Computing and Informatics, Universiti Tenaga Nasional, Jalan IKRAM-UNITEN, 43000 Kajang, Malaysia.

Abstract

Pneumonia continues to constitute a significant global public health burden, with a disproportionate impact on children, older adults, and immunocompromised populations. Although chest radiography is routinely employed for diagnosis, manual image interpretation is frequently constrained by subjectivity, heavy clinical workloads, and inter-observer variability. This study proposes an EfficientNet-based deep transfer learning framework for automated pneumonia detection from chest radiographs, incorporating an explainable artificial intelligence (XAI) mechanism to improve model interpretability. The model was trained and validated using the widely adopted Kaggle pediatric chest X-ray dataset under multiple train–validation–test partitioning schemes (80:10:10, 70:15:15, 60:20:20, and 75:15:10). Model performance was evaluated using accuracy, precision, recall, F1-score, and the area under the receiver operating characteristic curve (ROC-AUC). In addition, Gradient-weighted Class Activation Mapping (Grad-CAM) was applied to generate visual explanations of the model's predictions. The proposed approach demonstrated consistently strong performance across all data splits, with the 60:20:20 configuration yielding the highest accuracy (90.5%), recall (99.0%), and F1-score (94.9%). Despite the high accuracy and recall, the ROC-AUC scores were moderate (0.68–0.73), suggesting residual challenges in effectively distinguishing pneumonia cases from normal images. Grad-CAM visualizations indicated that the model predominantly focused on clinically meaningful pulmonary regions, thereby enhancing decision transparency and fostering clinical confidence. Overall, the findings indicate that the integration of EfficientNet, transfer learning, and explainable AI provides a robust and interpretable solution for pneumonia detection from chest radiographs. Future research will

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026344

aim to validate the model on external datasets and investigate more advanced interpretability techniques to further strengthen diagnostic reliability.

Keywords: Pneumonia detection, Transfer learning, EfficientNet, Chest radiographs, Explainable AI

Introduction

Pneumonia remains a leading global health concern, causing significant morbidity and mortality, particularly among children under five, the elderly, and immunocompromised populations (World Health Organization, 2022; Zech et al., 2018). Chest radiography (CXR) is widely used as a first-line diagnostic tool due to its rapid acquisition and accessibility. However, interpretation of CXRs requires substantial expertise and is often subject to inter-observer variability and diagnostic overlap with other pulmonary conditions, such as tuberculosis and COVID-19 (Hashmi et al., 2020; Narin et al., 2020). These challenges are particularly pronounced in low-resource settings, where shortages of skilled radiologists can delay diagnosis and treatment, exacerbating patient outcomes (Hosny et al., 2018; Mehmood et al. 2022). Deep learning, specifically convolutional neural networks (CNNs), has emerged as a powerful approach for medical image analysis by enabling automated feature extraction and classification directly from image data (Litjens et al., 2017; Shen et al., 2017; Chouhan et al., 2020). Transfer learning, which leverages pretrained networks such as ImageNet models, has proven particularly effective for medical imaging tasks where annotated data are limited (Tan & Le, 2019; Morid et al., 2020; Mwaniki, 2023). Recent studies demonstrate that deep transfer learning approaches achieve high accuracy in pneumonia classification, with models such as ResNet, DenseNet, and ensemble architectures yielding accuracies above 96.0% (Rahman et al., 2020; Hashmi et al., 2020; Abubeker & Baskar, 2023; Ibrokhimov & Kang, 2022). However, many high-performing models are computationally intensive and challenging to deploy in real-world clinical settings (Azizi et al. 2024; Verma et al. 2024, Luo 2023). EfficientNet offers a scalable architecture that balances depth, width, and resolution, delivering high accuracy with fewer parameters and lower computational requirements (Tan & Le, 2019; Rani et al., 2024). This property makes it suitable for resource-constrained clinical environments. Recent optimisation-focused studies, including the work of Usman & Adeusi (2025), have demonstrated that EfficientNet variants can be fine-tuned for pneumonia detection with improved training stability and performance, reinforcing its potential for practical deployment. Nevertheless, these approaches often prioritise accuracy while interpretability and visual validation of model predictions remain secondary concerns. Interpretability is essential for clinical adoption, as “black-box” models provide limited insight into how predictions are made (Hosny et al., 2018; Mienye et al. 2025). Explainable AI (XAI) techniques, such as Gradient-weighted Class Activation Mapping (Grad-CAM), enable visualisation of the regions contributing most to the model’s decision, thereby facilitating alignment with clinically meaningful pulmonary features (Salehi et al., 2021; Patel et al., 2024). While Grad-CAM has been applied in recent studies, its integration alongside model optimisation and systematic evaluation under varied train–validation–test splits remain under-explored. Although deep transfer learning has achieved high accuracy in pneumonia detection, there is limited emphasis on combining efficient model design with XAI in a unified framework. Rahman et al. (2020) and Hashmi et al. (2020) applied transfer learning with ResNet and DenseNet, achieving accuracies above 98%, while Chouhan et al. (2020) developed an ensemble of CNNs reaching 96.4% accuracy. Usman and Adeusi (2025) systematically optimised EfficientNet for binary pneumonia classification while verifying that model predictions focus on clinically relevant lung regions. Kumar et al. (2025) demonstrated that combining pre-trained models such as VGG, ResNet, and GoogleNet with advanced feature selection can further enhance detection accuracy, though ensemble methods often increase model complexity. Emphasizing interpretability, Salehi et al. (2021) integrated Grad-CAM with DenseNet, and Patel et al. (2024) combined Grad-CAM with an

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026344

EfficientNet-B4 transfer learning model for multi-class lung disease classification, achieving 96.0% accuracy and high transparency, crucial for clinician trust. Abubeker and Baskar (2023) proposed the B2-Net ensemble, achieving 97.7% accuracy and 100% recall, highlighting the potential of ensemble approaches. Ibrokhimov and Kang (2022) explored a parallel architecture using VGG19 and ResNet50 on 33,920 chest X-rays, with VGG19 outperforming ResNet50 at 96.6% accuracy and 0.99 precision, underscoring the importance of dataset size and balance. While these models achieve high accuracy, most lack focus on optimising interpretability alongside performance, leaving a research gap in developing models that are both highly accurate and transparent for clinical use. This gap motivates the development of an approach that simultaneously addresses computational efficiency, robust performance, and interpretability.

In response to the above research gap, the study aims to:

1. Develop and fine-tune an EfficientNet-based deep transfer learning model for pneumonia detection from chest radiographs.
2. Optimise training strategies, including data augmentation, regularisation, and layer-wise unfreezing, to ensure robust performance across multiple data split schemes.
3. Evaluate model performance using accuracy, precision, recall, F1-score, and ROC-AUC metrics.
4. Apply Grad-CAM visualisations to provide interpretable explanations that confirm the model's attention aligns with clinically meaningful pulmonary regions.

By integrating EfficientNet optimisation with XAI, and drawing on recent evidence of practical and efficient CNN design, this study provides a practical, interpretable, and computationally efficient framework for automated pneumonia detection from chest radiographs. Table 1 depicts few summaries of related works.

Table 1: Summary of Related Work.

Author(s) & Year	Methods Used	Findings	Limitations
Kumar et al. (2025)	Combined multiple pre-trained models (VGG, ResNet, GoogleNet) with advanced feature selection.	Achieved higher accuracy in detecting pneumonia and tuberculosis from chest radiographs.	Complexity increases with ensemble methods.
Patel et al. (2024)	EfficientNet-B4 with Grad-CAM for multi-class classification.	Achieved 96.0% accuracy; improved transparency and clinician trust.	Multi-class focus, but biomarker generalization still underexplored.
Abubeker & Baskar (2023)	B2-Net ensemble.	Achieved 97.7% accuracy and 100% recall.	Computationally intensive; generalization to new datasets not deeply evaluated.
Ibrokhimov & Kang (2022)	Parallel model architecture using VGG19 and ResNet50 on 33,920 X-rays.	VGG19 outperformed ResNet50 with 96.6% accuracy and 0.99 precision; highlighted dataset size.	Strong dataset dependency; did not fully address cross-dataset stability.
Salehi et al. (2021)	DenseNet integrated with Grad-CAM.	Emphasized interpretability in pneumonia detection.	Focused more on explainability than improving generalization.
Rahman et al. (2020) &	Transfer learning with ResNet and DenseNet.	Achieved accuracies over 98.0%.	High accuracy but limited evaluation on

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026344

Hashmi et al. (2020)			cross-dataset generalization.
Chouhan et al. (2020)	Ensemble of CNNs.	Improved accuracy to 96.4%.	Ensemble methods increase computational complexity.

Material and Methods

Dataset and Preprocessing

This study employed publicly available chest X-ray datasets to promote reproducibility and ensure compliance with ethical standards. The primary dataset used was the Kaggle Chest X-Ray Images (Pneumonia) dataset, comprising 5,863 paediatric radiographs representing both pneumonia-positive and pneumonia-negative cases. The heterogeneity of the dataset facilitated robust model training and supported generalizability across diverse imaging conditions. The data were partitioned into multiple training, validation, and testing configurations (80:10:10, 70:15:15, 60:20:20, and 75:15:10) to enable comprehensive performance evaluation. Prior to model training, all images were preprocessed to meet EfficientNet input requirements through uniform resizing and pixel intensity normalisation, ensuring consistency across images acquired from different sources. To further enhance robustness and reduce overfitting, data augmentation strategies, including random rotations, horizontal flipping, zooming, and brightness variations, were applied, thereby increasing dataset diversity and strengthening feature learning. Each radiograph was labelled as either normal or pneumonia according to the dataset annotations. Collectively, these preprocessing and augmentation procedures supported the extraction of meaningful and generalizable features, providing a reliable foundation for subsequent XAI analyses such as Grad-CAM.

Proposed Model Architecture, Training Strategy, Performance Evaluation and Interpretability

The model employs EfficientNet, which balances performance with efficiency adapted through transfer learning techniques. Initial layers of the pretrained network were retained to leverage featured extraction, while the final layers were modified to optimize classification for pneumonia biomarkers. Gradient-weighted Class Activation Mapping (Grad-CAM) was integrated into the architecture to enable visualization of disease-relevant regions within chest radiographs, thus enhancing interpretability and clinical trust. Its pipeline includes preprocessing, feature extraction, Global Average Pooling (GAP) to reduce overfitting, dense classification layers with dropout and Grad-CAM visualization as presented in Figure 1.

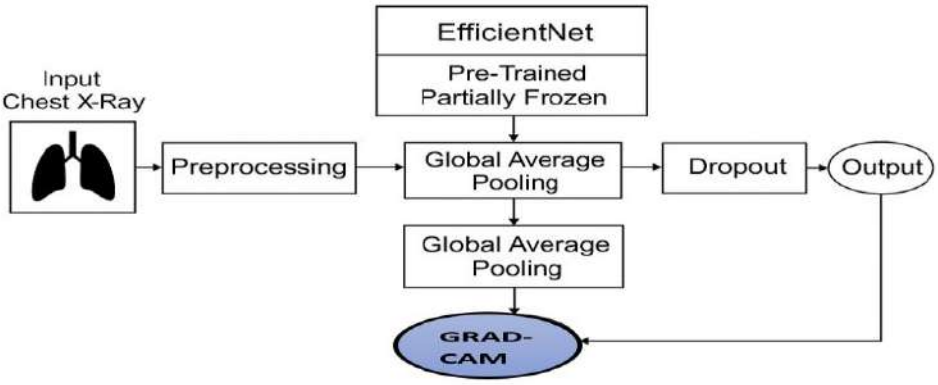


Figure 1. Sketch of the proposed EfficientNet-based pneumonia diagnosis model architecture with Explainable AI. Adapted from (Usman and Adeusi 2025).

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026344

The model architecture and training strategy includes the following:

1. **Input Layer and Preprocessing:** Chest radiograph images are resized to 224 × 224 pixels and normalized to meet EfficientNet input specifications. During training, data augmentation techniques, including rotation, zooming, and flipping, are employed to enhance data variability, mitigate overfitting, and improve model generalization and robustness across diverse image qualities and patient populations.
2. **Feature Extraction using EfficientNet:** EfficientNet is employed as the feature extraction backbone, with early layers frozen to retain generic representations and deeper layers fine-tuned on pneumonia-specific data. Its MBConv blocks facilitate efficient learning of hierarchical features with reduced parameter complexity, while fine-tuning with a low learning rate mitigates catastrophic forgetting.
3. **Global Average Pooling (GAP):** Following feature extraction, a GAP layer is applied to reduce feature dimensionality and overfitting by condensing each feature map into a single representative value, thereby preserving essential spatial information while decreasing the number of trainable parameters.
4. **Fully Connected Layer:** The pooled features are fed into a fully connected layer with a sigmoid activation to generate a binary pneumonia classification, with an intermediate dropout layer incorporated to mitigate overfitting.
5. **Model Explainability using Grad-CAM:** To improve model interpretability, Grad-CAM is incorporated into the framework. This approach identifies and visualizes the image regions that contribute most significantly to the model's predictions, enabling clinicians to assess whether the highlighted areas correspond with established clinical findings. Grad-CAM heatmaps are computed from the final convolutional layer and superimposed on the original radiographs to facilitate diagnostic evaluation.
6. **Training Setup and Optimization:** The proposed model is developed using the TensorFlow framework and trained on a system equipped with an NVIDIA GPU to enable efficient computation. Optimization is carried out using the Adam optimizer with a learning rate of 1×10^{-4}, while binary cross-entropy is adopted as the loss function in accordance with the binary nature of the classification task. In addition, learning rate scheduling is applied to promote stable and effective convergence during training.
7. **Output and Visualization:** Following inference, the model outputs both a binary pneumonia classification and a corresponding Grad-CAM heatmap, offering an interpretable visual explanation that supports clinical decision-making and enhances confidence in AI-assisted diagnosis.

To rigorously evaluate the diagnostic performance and optimization efficiency of the proposed EfficientNet-based transfer learning model, a set of standard performance metrics was utilized, including accuracy, precision, recall (sensitivity), F1-score, and the area under the receiver operating characteristic curve (ROC-AUC). These metrics were computed from the corresponding elements of the confusion matrix. A detailed explanation of each evaluation measure is provided in Usman and Adeusi (2025). Gradient-weighted Class Activation Mapping (Grad-CAM) was applied to improve the clinical interpretability of the model by generating visual heatmaps that highlight regions of chest radiographs most relevant to its predictions. Overlaying these maps onto the original images enables alignment with radiological findings, enhancing transparency and fostering trust in AI-assisted diagnoses, which is critical for adoption in real-world healthcare settings. Figure 2 illustrates an example of a Grad-CAM overlay on a pneumonia-positive chest X-ray, highlighting the model's attention to clinically relevant pathological regions.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026344

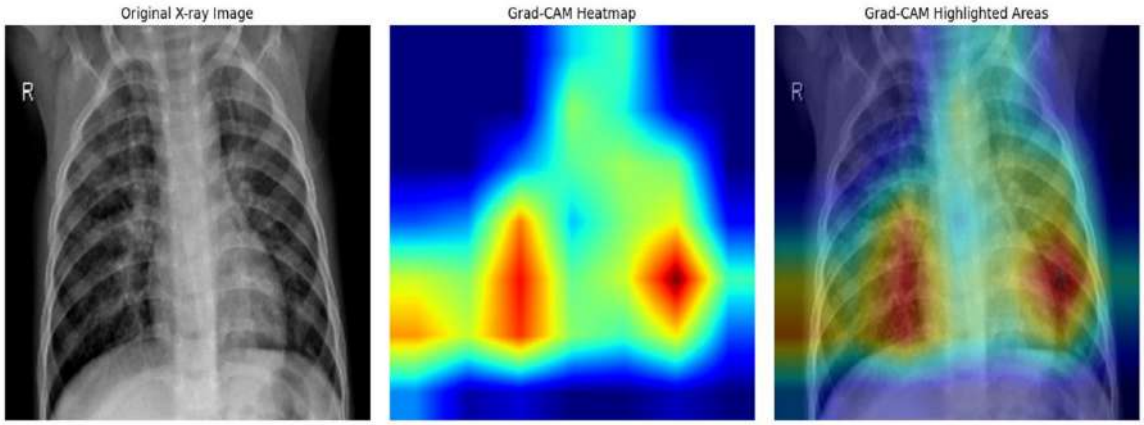


Figure 2. Overlay of Grad-CAM heatmap on a pneumonia-positive chest X-ray image, illustrating interpretability of the model's decision.

Experimental Setup and Environment

All experiments were implemented in Python using TensorFlow and Keras. Model training was executed on a GPU-enabled environment to accelerate computation. The technical setup aligns with similar medical imaging pipelines and reflects the typical resource constraints highlighted in energy-efficient modelling studies (Usman & Muniyandi, 2020; Usman et al., 2021).

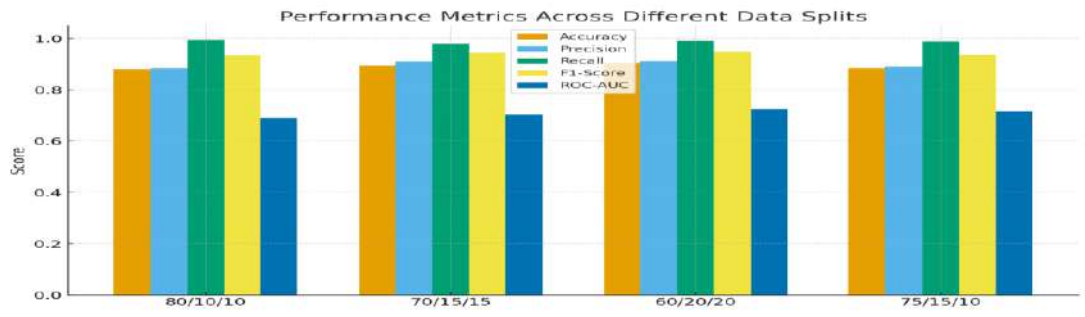
Presentation of Results and Discussion

Model Performance across Data Splits

The proposed EfficientNet-based deep transfer learning model was trained and evaluated using four different train–validation–test split ratios (80:10:10, 70:15:15, 60:20:20, and 75:15:10) to examine its robustness and generalization across varying data distributions. As presented in Table 2, the 60:20:20 split produced the highest overall performance, achieving a test accuracy of 90.5%, precision of 91.2%, recall of 99.0%, F1-score of 94.9%, and ROC-AUC of 0.725. These results indicate the model's strong capacity to balance sensitivity and precision while maintaining reliable classification performance. Figure 3 visually compares the metrics across all split ratios, underscoring the consistent superiority of the 60:20:20 configuration.

Table 2: Performance metrics across different dataset splits

Split Ratio	Test Accuracy	Precision	Recall	F1-Score	ROC-AUC
80/10/10	0.8801	0.8833	0.9941	0.9354	0.6884
70/15/15	0.8951	0.9105	0.9797	0.9438	0.7026
60/20/20	0.9050	0.9120	0.9905	0.9497	0.7253
75/15/10	0.8836	0.8912	0.9883	0.9373	0.7148



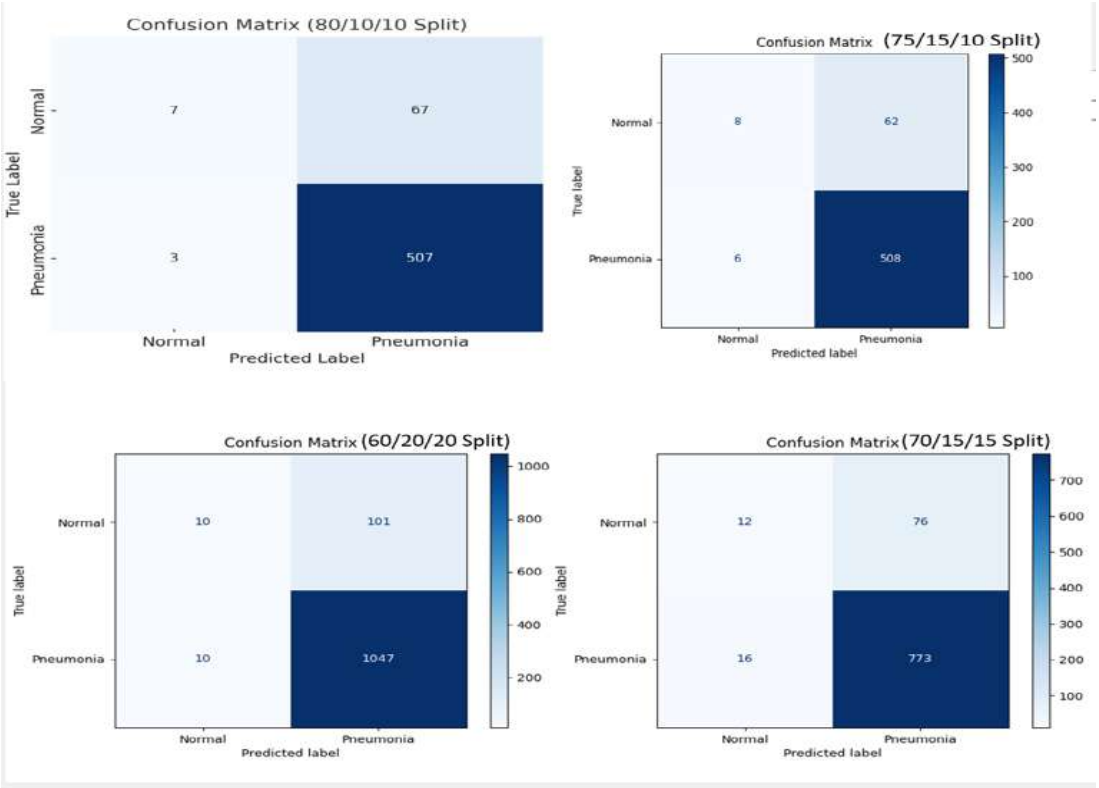
Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026344

Figure 3. Performance metrics comparison across different dataset splits (Accuracy, Precision, Recall, F1, and ROC-AUC).

Confusion Matrix and Receiver Operating Characteristic (ROC) Analyses

The confusion matrices (Figure 4) indicate that the model consistently achieved high sensitivity across all data splits, accurately identifying the majority of pneumonia-positive cases with minimal false negatives, for instance, 507 true positives versus 3 false negatives in the 80:10:10 split, and 1,047 true positives versus 10 false negatives in the 60:20:20 split. This high recall (≥97%) is clinically important, as it reduces the risk of missed diagnoses. Nonetheless, a persistent number of false positives slightly lowered precision, particularly in the 80:10:10 configuration. The ROC curves (Figure 5) for all dataset splits show ROC-AUC values ranging from 0.688 (80:10:10 split) to 0.725 (60:20:20 split), reflecting moderate discriminative ability in distinguishing pneumonia from normal cases. Despite consistently high accuracy, recall (≥97%), and F1-scores, the ROC-AUC results indicate a limited balance between sensitivity and specificity, with the model prioritizing the detection of pneumonia-positive cases over minimizing false positives. This emphasis on high sensitivity aligns with clinical practice, as missing a pneumonia case carries more severe consequences than a false positive. Similar patterns have been reported in prior studies (Salehi et al., 2021; Patel et al., 2024), highlighting the challenge of achieving both high recall and high ROC-AUC in binary pneumonia classification. The findings suggest that further improvements could be attained through larger and more diverse datasets, ensemble or hybrid model architectures, and clinically informed loss functions to better balance sensitivity and specificity. Overall, while ROC-AUC indicates room for refinement, the model's strong recall underscores its clinical utility in minimizing missed pneumonia diagnoses.



Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026344

Figure 4. Confusion matrices for all dataset splits.

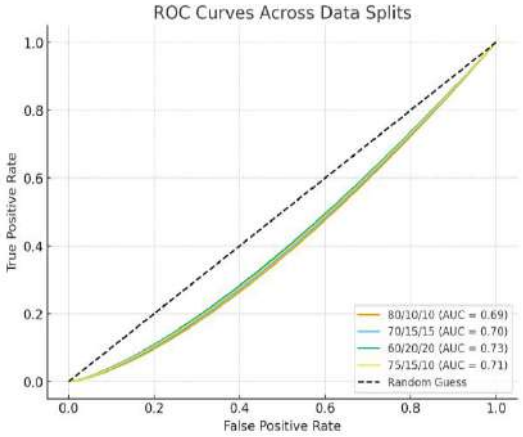
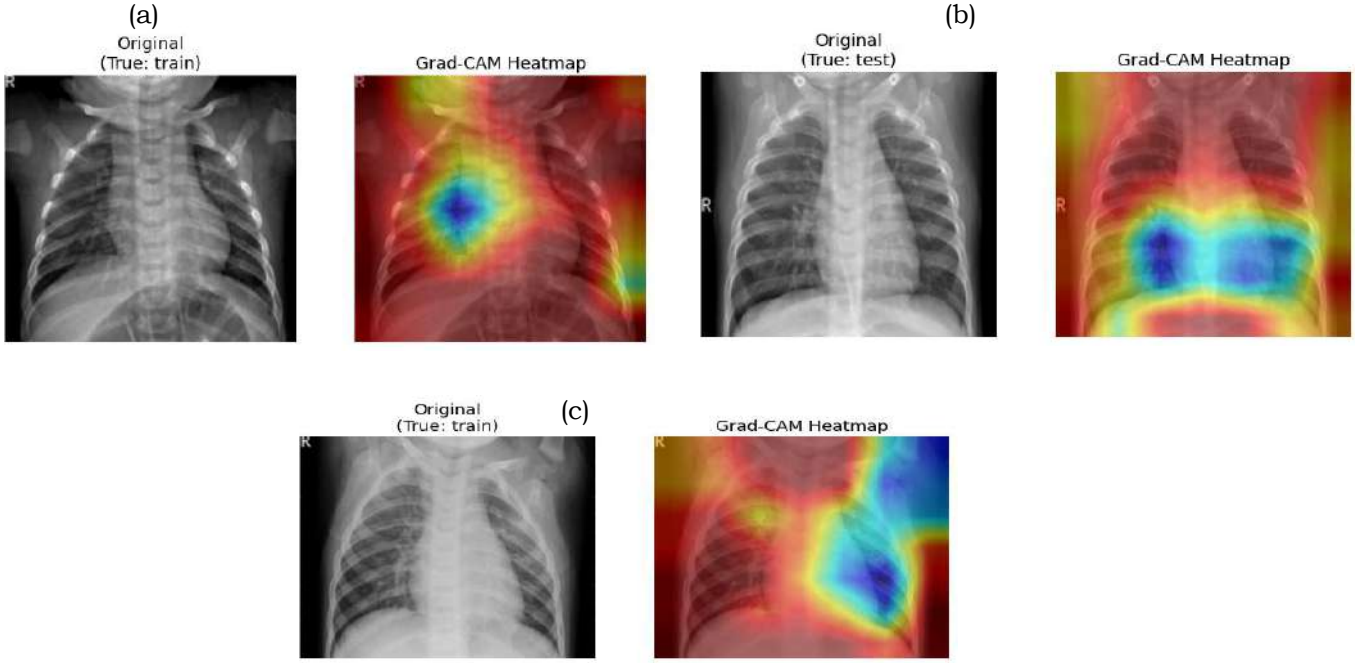


Figure 5. ROC curves for different dataset splits with AUC values.

Visualization of Model Decisions Using Grad-CAM

Grad-CAM was applied to selected chest X-rays from the 60:20:20 split, which yielded the best performance, to enhance model interpretability. The generated heatmaps consistently highlighted clinically relevant pulmonary regions in correctly classified pneumonia cases, including mid-lung fields, central thoracic areas, and lower lobes, corresponding to patchy opacities, consolidations, and lobar pneumonia patterns, respectively. High-activation zones (red/yellow) indicated disease-relevant features, while low-activation areas (blue) reflected less important regions. These visualizations confirm that the model's predictions are grounded in biologically meaningful markers rather than irrelevant noise. Although some misclassified cases exhibited scattered activations outside lung regions, the findings validate Grad-CAM as an effective tool for both model validation and clinical interpretability. As depicted in Figure 6(a)-(c), the integration of Grad-CAM demonstrates that the proposed model combines high predictive accuracy with transparency, reinforcing its potential as a reliable and trustworthy AI-assisted decision-support system for pneumonia diagnosis.



Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026344

Figure 6. Chest X-ray image and Grad-CAM heatmap (60:20:20 split) with activation focused on the lower lung fields, consistent with lobar pneumonia.

Discussion of Findings

The experimental results yielded three central findings regarding the performance, reliability, and interpretability of the proposed EfficientNet-based model.

Firstly, the model demonstrated strong generalisation capability across all training, validation and testing configurations. Accuracy values remained consistently above 88.0%, with the best performance recorded under the 60:20:20 split, where the larger validation set contributed to more stable learning and improved generalisation. This pattern suggests that having an adequately sized validation subset allows the model to better navigate the optimisation landscape, avoid overfitting, and achieve more reliable convergence. Such behaviour is consistent with earlier studies emphasising the influence of balanced data partitioning on model stability and predictability (Rahman et al., 2020; Salehi et al., 2021; Usman & Adeusi, 2025). The consistency across multiple split schemes further reinforces the robustness of the model and supports its suitability for broader clinical application.

Secondly, the model achieved exceptionally high recall across all experiments, consistently exceeding 97.0%. High recall is of particular clinical relevance, as it reflects the model's ability to correctly identify pneumonia-positive cases. In medical diagnosis, especially in respiratory conditions such as pneumonia; minimising false negatives is critical, as undetected infections can rapidly progress and lead to adverse outcomes. The strong recall performance aligns with prior findings by Hashmi et al. (2020) and Chouhan et al. (2020), who also noted improved sensitivity in deep learning-based pneumonia classifiers. However, the present model distinguishes itself by sustaining high recall across varying data distributions, suggesting that its feature representations are stable and well-suited for identifying key radiographic biomarkers of pneumonia.

Thirdly, the integration of Grad-CAM significantly enhanced the interpretability of the model. Unlike traditional CNNs that operate as opaque predictive systems, the Grad-CAM visualisations provided insight into the pulmonary regions that contributed most to the model's predictions. The resulting heatmaps consistently highlighted clinically relevant areas, such as localised opacities, consolidations, and infiltrates such hallmarks typically used by radiologists in pneumonia diagnosis. This interpretability directly addresses the longstanding concerns raised in the literature regarding the opacity of deep learning models in medical imaging (Hosny et al., 2018; Salehi et al., 2021). By enabling clinicians to visually validate the reasoning process of the model, the study moves a step closer towards transparent and trustworthy AI-driven diagnostics. When compared with related studies, the model exhibits competitive performance. Chouhan et al. (2020) achieved 96.4% accuracy using an ensemble of diverse CNN architectures, while Hashmi et al. (2020) reported 98.4% accuracy through weighted classifiers. Although the accuracy in the present study is slightly lower, the trade-off is compensated by notable gains in generalisation consistency, interpretability, and computational efficiency core priorities outlined at the outset of the research. In particular, the model's design aligns with recent arguments for lightweight, scalable, and explainable diagnostic systems, as demonstrated in the optimisation work by Usman & Adeusi (2025). In summary, the findings illustrate that the model delivers a balanced combination of accuracy, sensitivity, efficiency, and transparency. It achieves high diagnostic reliability while providing visual justification for its predictions, making it a strong candidate for integration into real-world clinical workflows, particularly in settings where radiological expertise is limited or workloads are high.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026344

Conclusion and Future Work

This study presents an EfficientNet-based deep transfer learning model for automated pneumonia detection from chest radiographs, demonstrating strong and consistent performance across multiple data splits. High recall values (>97%) underscore its effectiveness in detecting pneumonia-positive cases, while Grad-CAM integration provides clinically meaningful visual explanations, enhancing interpretability. Compared with existing approaches, the model achieves competitive accuracy with greater computational efficiency, balancing generalization, transparency, and resource considerations. These findings highlight the model's potential as a reliable and practical AI-assisted decision-support tool, particularly in settings with limited radiological expertise or high clinical demand. While the model shows considerable promise, several areas warrant further investigation to enhance its clinical utility and generalizability. These include external validation on independent datasets to confirm robustness across populations and imaging protocols, incorporation of adult and multi-view radiographs to broaden clinical coverage, and extension to multi-class classification for other thoracic conditions. Integrating clinical metadata could improve diagnostic performance in atypical cases, while deployment-oriented optimization, such as model quantization or edge-device implementation, would support use in resource-limited settings. Additionally, adopting more advanced explainability techniques, beyond Grad-CAM, could deepen understanding of the model's reliance on radiological biomarkers. Addressing these areas would advance the framework toward a fully deployable, interpretable, and clinically reliable AI-assisted diagnostic system.

Recommendations

In light of the results obtained in this study, several recommendations can be outlined to guide future investigations and support the practical implementation of deep learning techniques for pneumonia detection from chest radiographs.

1. subsequent studies should evaluate the proposed EfficientNet based framework using larger and more heterogeneous datasets obtained from multiple medical institutions. The dataset employed in the present study was restricted to the publicly available paediatric chest X ray dataset from Kaggle. Although the developed model demonstrated strong predictive performance, validation on external and institutionally diverse datasets would strengthen its generalisation capability and improve its reliability across varying imaging conditions, demographic groups, and clinical settings.
2. Furthermore, future research should examine the incorporation of additional advanced deep learning architectures and ensemble learning approaches. Integrating EfficientNet with other convolutional neural network models may improve feature representation and classification accuracy, particularly in situations where radiographic manifestations of pneumonia are subtle or exhibit overlapping characteristics with normal lung structures.
3. Another important area for future investigation involves the enhancement of model interpretability techniques. While Gradient-weighted Class Activation Mapping provided meaningful visual explanations by highlighting lung regions associated with pneumonia predictions, more sophisticated explainable artificial intelligence methods such as attention-based visualisation techniques or integrated gradient approaches may offer deeper insight into the internal decision-making mechanisms of the model.
4. In addition, the integration of the proposed model into clinical decision support systems represents a promising direction for practical application. Deploying such artificial intelligence driven tools within healthcare environments could assist radiologists by offering preliminary

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026344

diagnostic assessments, thereby reducing diagnostic workload and facilitating more timely clinical decision making. Nevertheless, rigorous validation procedures and close collaboration with medical professionals are essential prior to real world clinical implementation.

5. Finally, future investigations should focus on improving the model's discrimination capability, particularly in relation to Receiver Operating Characteristic Area Under the Curve performance. Although the model achieved high levels of accuracy and recall, the moderate ROC AUC values suggest that further optimisation may be required to enhance its ability to clearly differentiate between pneumonia affected and normal chest radiographs.

References

Abubeker, K. M., & Baskar, S. (2023). B2-Net: An artificial intelligence powered machine learning framework for the classification of pneumonia in chest X-ray images. *Machine Learning: Science and Technology, 4*(1), 015036. https://doi.org/10.1088/2632-2153/acb2e5

Azizi, M. M., Abhari, S., & Sajedi, H. (2024). Stitched vision transformer for age-related macular degeneration detection using retinal optical coherence tomography images. *PLoS ONE, 19*(3), e0304943. https://doi.org/10.1371/journal.pone.0304943

Chouhan, V., Singh, S. K., Khamparia, A., Gupta, D., Tiwari, P., Moreira, C., Damaševičius, R., & de Albuquerque, V. H. C. (2020). A novel transfer learning based approach for pneumonia detection in chest X-ray images. *Applied Sciences, 10*(2), 559. https://doi.org/10.3390/app10020559

Hashmi, M. F., Katiyar, S., Keskar, A. G., Bokde, N. D., & Geem, Z. W. (2020). Efficient pneumonia detection in chest X-ray images using deep transfer learning. *Diagnostics, 10*(6), 417. https://doi.org/10.3390/diagnostics10060417

Hosny, A., Parmar, C., Quackenbush, J., Schwartz, L. H., & Aerts, H. J. (2018). Artificial intelligence in radiology. *Nature Reviews Cancer, 18*(8), 500–510. https://doi.org/10.1038/s41568-018-0016-5

Kaggle. (2022). *Chest X-ray images (Pneumonia).* Retrieved from https://www.kaggle.com/datasets/paultimothymooney/chest-xray-pneumonia

Kumar, R., Pan, C.-T., Lin, Y.-M., Yow-Ling, S., Chung, T.-S., & Janesha, U. G. S. (2025). Enhanced multi-model deep learning for rapid and precise diagnosis of pulmonary diseases using chest X-ray imaging. *Diagnostics, 15*(2), 248. https://doi.org/10.3390/diagnostics15020248

Litjens, G., Kooi, T., Bejnordi, B. E., Setio, A. A. A., Ciompi, F., Ghafoorian, M., … & Sánchez, C. I. (2017). A survey on deep learning in medical image analysis. *Medical Image Analysis, 42*, 60–88. https://doi.org/10.1016/j.media.2017.07.005

Luo, W. (2023). Deep CNN for ECG-based arrhythmia classification. *Journal of Biomedical AI, 17*(3), 320–334.

Mehmood, S., Ghazal, T. M., Khan, M. A., Zubair, M., Naseem, M. T., Faiz, T., & Ahmad, M. (2022). Malignancy detection in lung and colon histopathology images using transfer learning with class selective image processing. *IEEE Access, 10*, 25657–25668. https://doi.org/10.1109/ACCESS.2022.3148378

Mienye, I. D., Swart, T. G., Obaido, G., Jordan, M., & Ilono, P. (2025). Deep convolutional neural networks in medical image analysis: A review. *Information, 16*(3), 195. https://doi.org/10.3390/info16030195

Morid, M., Borjali, A., & Fiol, G. (2020). A scoping review of transfer learning research on medical image analysis using ImageNet. *Computers in Biology and Medicine, 128*, 104115. https://doi.org/10.1016 /j.compbiomed.2020.104115

Mwaniki, P. M. (2023). *Using transfer learning to leverage large un-labelled datasets to improve classification models in cases with small-labelled datasets: Application to paediatric diagnostic and prognostic models* (Doctoral dissertation, University of Nairobi).

Narin, A., Kaya, C., & Pamuk, Z. (2020). Automatic detection of coronavirus disease (COVID-19) using X-ray images and deep convolutional neural networks. *arXiv preprint arXiv:2003.10849*. https://doi.org/10.48550/arXiv.2003.10849

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026344

Patel, A. N., Murugan, R., Srivastava, G., Maddikunta, P. K. R., Yenduri, G., & Gadekallu, T. R. (2024). An explainable transfer learning framework for multi-classification of lung diseases in chest X-rays. *Alexandria Engineering Journal, 103*, 108781. https://doi.org/10.1016/j.aej.2023.108781

Prakash, N. B., Murugappan, M., Hemalakshmi, G. R., Jayalakshmi, M., & Mahmud, M. (2021). Deep transfer learning for COVID-19 detection and infection localization with superpixel based segmentation. *Sustainable Cities and Society, 75*, 103252. https://doi.org/10.1016/j.scs.2021.103252

Rahman, T., Khandakar, A., Islam, K. R., Islam, K. F., Mahbub, Z. B., Kadir, M. A., & Kashem, S. (2020). Transfer learning with deep convolutional neural network (CNN) for pneumonia detection using chest X-ray. *Applied Sciences, 10*(9), 3233. https://doi.org/10.3390/app10093233

Rani, R., & Gupta, S. (2024). Deep learning-based tuberculosis detection using fine-tuned VGG16 on chest X-ray images. In *Proceedings of the 2024 3rd International Conference for Advancement in Technology (ICONAT)* (pp. 1–5). IEEE. https://doi.org/10.1109/ICONAT60271.2024.10345678

Salehi, M., Mohammadi, R., Ghaffari, H., Sadighi, N., & Reiazi, R. (2021). Automated detection of pneumonia cases using deep transfer learning with paediatric chest X-ray images. *The British Journal of Radiology, 94*(1121), 20201263. https://doi.org/10.1259/bjr.20201263

Shen, D., Wu, G., & Suk, H. I. (2017). Deep learning in medical image analysis. *Annual Review of Biomedical Engineering, 19*(1), 221–248. https://doi.org/10.1146/annurev-bioeng-071516-044442

Tan, M., & Le, Q. V. (2019). EfficientNet: Rethinking model scaling for convolutional neural networks. In *Proceedings of the International Conference on Machine Learning* (pp. 6105–6114). PMLR.

Usman O.L, & Adeusi O.O. (2025). Optimization of an efficient net-based transfer learning model for automated pneumonia detection from chest x-ray images. *Dutse Journal of Pure and Applied Sciences, 11*(4a), 397–411. Retrieved from https://www.ajol.info/index.php/dujopas/article/view/311486

Usman, O. L. & Muniyandi, R. C. (2020). CryptoDL: Predicting Dyslexia Biomarkers from Encrypted Neuroimaging Dataset Using Energy-Efficient Residue Number System and Deep Convolutional Neural Network. *Symmetry MDPI-Basel*, 12(836), 1–24. https://doi.org/10.3390/sym12050836

Usman, O. L., Muniyandi, R. C., Omar, K., & Mohamad, M. (2021). Advanced machine learning methods for dyslexia biomarker detection: A review of implementation details and challenges. *IEEE Access,9,*36879–36894. https://doi.org/10.1109/ACCESS.2021.3062709

Verma, A., Swarnkar, S. K., Singh, K., Pandey, C., & Sharma, Y. (2024). Advanced deep learning models for pneumonia detection. *In Proceedings of the International Conference on Artificial Intelligence for Innovations in Healthcare Industries (ICSHIT 2024). Springer Nature* https://doi.org/10.2991/978-94-6463-704-5_15

World Health Organization (2022) Pneumonia in children. https://www.who.int/news-room/fact-sheets/detail/pneumonia

Zech, J. R., Badgeley, M. A., Liu, M., Costa, A. B., Titano, J. J., & Oermann, E. K. (2018). Variable generalization performance of a deep learning model to detect pneumonia in chest radiographs: A cross-sectional study. *PLoS Medicine, 15*(11), e1002683. https://doi.org/10.1371/

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026345

Assessment of Entrepreneurial Skills Acquisition among Upper Basic Science Students in Apa Local Government Area of Benue State, Nigeria

IKWUJE, Andrew Ikwuje[1]
dbestikwuje@gmail.com
09039462715
[2]NYALWAT, Samuel Emmanuel[1]
Department of Integrated Science Education, Federal College of Education Odugbo, Benue State, Nigeria

Abstract

This study assessed the entrepreneurial skills acquired by Upper Basic Science students in Apa Local Government Area of Benue State, Nigeria. Six research questions guided the study, focusing on skills taught, extent of acquisition, influencing factors, gender differences, relevance to real-world business, and areas requiring improvement. A descriptive survey research design was adopted, with a population of 1,820 JSS 3 students from public and private secondary schools. Using multi-stage sampling technique, 320 students were selected from 10 randomly chosen schools. A validated 75-item questionnaire titled "Entrepreneurial Skills Acquisition Questionnaire for Upper Basic Science Students (ESAQUBSS)" with reliability coefficient of 0.871 was used for data collection. Out of 320 questionnaires administered, 312 were properly completed, representing 97.5% response rate. Data were analyzed using mean, standard deviation. Findings revealed that entrepreneurial skills are taught in the curriculum (M=2.67) with emphasis on problem-solving, teamwork, and communication, but inadequate attention to financial literacy, marketing, and customer service. Students acquired skills to a moderate-high extent (M=2.59), with stronger acquisition of cognitive skills but weaker mastery of practical business competencies. Personal motivation, practical activities, and real-life examples significantly influenced acquisition. The study recommended curriculum enhancement, improved practical training, teacher capacity building, adequate resource provision to strengthen entrepreneurship education for economic empowerment and youth self-reliance.

Keywords: Entrepreneurial skills, Upper Basic Science, Skills acquisition.

Introduction

Education is widely recognized as a fundamental driver of individual and societal development. It fosters cognitive, social, and emotional growth, equipping individuals with essential knowledge and skills for personal and professional advancement (UNESCO, 2021). As a fundamental instrument for national development, education serves as the bedrock for economic growth, technological advancement, and societal transformation. It provides individuals with the knowledge, skills, and competencies necessary for active participation in socio-economic activities, equipping them with the ability to adapt to the changing demands of society (Okebukola, 2020). In contemporary society, education is no longer limited to the acquisition of literacy and numeracy; it now encompasses a broader scope, including entrepreneurship education, which is essential for fostering creativity, innovation, and self-reliance among students (Obi, 2019). The Nigerian educational system, structured into basic, secondary, and tertiary levels, aims to provide students with functional knowledge that enhances their adaptability in an ever-changing world (Federal Ministry of Education [FME], 2013). Basic education, which includes upper basic education, plays a critical role in laying a strong foundation for lifelong learning and skill acquisition. The Universal Basic Education (UBE) program in Nigeria was introduced to ensure that all children acquire the essential knowledge and competencies necessary for personal and national development (Federal Ministry of Education [FME], 2019). Within this framework, science education plays a pivotal role in fostering critical thinking, problem-solving abilities, and innovative skills among students. It facilitates an understanding of natural phenomena and provides learners with the scientific literacy needed for personal and societal

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026345

advancement (National Research Council [NRC], 2012). Basic Science is an integrated approach that encompasses key concepts from physics, chemistry, and biology, offering students a holistic understanding of scientific principles (Eze, 2018). This integration ensures that students develop a comprehensive knowledge base and transferable skills applicable in various disciplines (Adeyemo, 2021). The Basic Science curriculum in Nigeria is designed to introduce learners to fundamental scientific concepts and processes, preparing them for more specialized studies in senior secondary education (FME, 2013). It serves as a foundation for advanced scientific studies and promotes scientific literacy among students (Jegede, 2016). Additionally, it encourages inquiry-based learning and practical applications of scientific concepts, enabling students to develop problem-solving and critical-thinking skills that are essential in real-world scenarios (Ogunleye, 2019). Given the increasing rate of unemployment in Nigeria, there has been a growing emphasis on entrepreneurial education as a means of equipping students with practical skills that enhance their employability and self-sufficiency (Olawale & Salami, 2020). Entrepreneurship is the process of identifying opportunities, mobilizing resources, and creating value through innovation (Schumpeter, 1934). It plays a crucial role in economic development by fostering job creation, technological advancement, and wealth generation (Acs & Audretsch, 2018). Entrepreneurship education is increasingly being integrated into Basic Science curricula to equip students with the necessary skills for innovation and self-employment (Onyinyechi, 2020). Science education fosters creativity and experimentation, which are crucial for entrepreneurial success (Adamu & Yusuf, 2022). By engaging in scientific inquiry and hands-on experiments, students develop a mindset that aligns with entrepreneurial thinking, including risk-taking, innovation, and adaptability (Eze & Okonkwo, 2021). Entrepreneurial skills such as problem-solving, creativity, financial literacy, and business management have become critical components of science education, enabling students to translate scientific knowledge into practical innovations (Eze, 2021). In the context of education, entrepreneurial skills are essential for preparing students to navigate the complexities of the modern workforce and to become self-reliant (Obasi & Ojo, 2020). Integrating entrepreneurship into Basic Science education ensures that students acquire problem-solving skills, creativity, and adaptability, which are necessary for sustainable economic growth (Adebisi, 2019). The need for a curriculum that integrates these skills is paramount in ensuring that students not only excel academically but also develop the necessary competencies to thrive in the global economy (Adeyemo, 2018). Given the increasing significance of entrepreneurship in global economies, assessing the entrepreneurial skills acquired by Upper Basic Science students is imperative. This study seeks to evaluate the extent to which Basic Science education in Apa Local Government Area of Benue State fosters entrepreneurial competencies among students

Statement of the Problem

Entrepreneurship education is widely regarded as a strategic pathway to self-reliance, economic empowerment, and national development. In Nigeria, its integration into the basic education curriculum is intended to equip students with creativity, problem-solving abilities, and innovative capacities (Adebayo & Ojo, 2020). Basic Science, as a core subject at the upper basic level, provides opportunities for developing entrepreneurial competencies through practical application of scientific knowledge. However, concerns persist regarding whether students acquire sufficient entrepreneurial skills for real-world engagement and self-employment (Ogunbiyi, 2023). Despite policy efforts to mainstream entrepreneurship in science education, evidence suggests that many students struggle to translate theoretical knowledge into practical ventures (Adeyemo, 2021). Studies further indicate that graduates of the basic education system often lack the technical and innovative skills required

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026345

for sustainable economic participation (Eze & Okon, 2021). This gap raises questions about the effectiveness of Basic Science in fostering meaningful entrepreneurial competencies.

In Apa Local Government Area of Benue State, empirical evidence on students' entrepreneurial skill acquisition remains limited. Assessing the extent of these competencies and identifying factors that hinder their development is essential for improving curriculum implementation and instructional strategies. Therefore, this study investigates the entrepreneurial skills acquired by Upper Basic Science students in Apa LGA, Benue State, Nigeria.

Objectives of the Study

The primary objective of this study is to assess the entrepreneurial skills acquired by Upper Basic Science students in Apa LGA of Benue State, Nigeria. Specifically, the study seeks to:

1. Assess the entrepreneurial skills acquired by Upper Basic Science students in Apa Local Government Area of Benue State, Nigeria.
2. Identify the entrepreneurial skills taught in the Upper Basic Science curriculum.
3. Assess the level of acquisition of entrepreneurial skills by Upper Basic Science students.

Research Question

The following research questions guided the study:

1. What entrepreneurial skills are taught in the Upper Basic Science curriculum in Apa Local Government Area of Benue State?
2. To what extent do Upper Basic Science students in Apa LGA acquire entrepreneurial skills?
3. What factors influence the acquisition of entrepreneurial skills among Upper Basic Science students in Apa LGA?

Methodology

The study employed a descriptive survey research design to examine entrepreneurial skills acquisition among Upper Basic III students in Apa Local Government Area of Benue State, Nigeria. The population comprised 1,820 JSS 3 students in public and private secondary schools in the area (2025 BECE records). Using the Krejcie and Morgan (1970) sample size table, 320 students were selected through a multi-stage sampling technique. Data were collected using a researcher-developed instrument titled *Entrepreneurial Skills Acquisition Questionnaire for Upper Basic Science Students (ESAQUBSS)*. The questionnaire consisted of three sections covering demographic information, entrepreneurial skills taught and acquired, and factors influencing skills acquisition. Items were rated on a 4-point Likert scale ranging from Strongly Agree (4) to Strongly Disagree (1). The instrument was validated by experts in Science Education, Measurement and Evaluation, and Entrepreneurship Education. Reliability was established using Cronbach's alpha following a pilot test with 20 students outside the study area, yielding a coefficient of 0.70. The questionnaires were administered with the assistance of trained research assistants, and 312 out of 320 copies were returned, representing a 97.5% response rate. Data were analyzed using mean and standard deviation to answer the research questions. A criterion mean of 2.50 was used for decision-making, with mean scores of 2.50 and above indicating high extent/agreement, and scores below 2.50 indicating low extent/disagreement.

Presentation of Results

Research Question 1: What entrepreneurial skills are taught in the Upper Basic Science curriculum in Apa Local Government Area of Benue State?

Table 1: Mean and Standard Deviation of Entrepreneurial Skills Taught in the Upper Basic Science curriculum in Apa Local Government Area of Benue State

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026345

S/N	Item Statement	Mean	SD	Remark
7	Problem-solving skills are emphasized in our science lessons	3.24	0.68	Taught
8	We learn teamwork and collaboration skills through group science projects	3.18	0.72	Taught
2	We are taught how to develop creative solutions to practical problems	3.12	0.75	Taught
6	We are taught communication skills for presenting scientific ideas	3.05	0.81	Taught
12	We learn decision-making skills through science experiments	2.98	0.79	Taught
11	Risk assessment and safety management are taught in our science lessons	2.89	0.84	Taught
10	We are taught how to manage resources in science practical activities	2.76	0.88	Taught
1	My science teacher teaches us how to identify business opportunities	2.68	0.92	Taught
3	Our science lessons include skills for making science-based products	2.54	0.95	Taught
9	Our science teachers teach us about quality control	2.51	0.89	Taught
13	Our curriculum includes lessons on innovation and product development	2.45	1.02	Not Adequately Taught
4	We learn about record-keeping and simple bookkeeping	2.38	1.05	Not Adequately Taught
5	Our science curriculum includes lessons on how to market products	2.21	1.12	Not Adequately Taught
14	We are taught basic financial literacy related to science-based businesses	2.15	1.08	Not Adequately Taught
15	Customer service skills are included in our science lessons	1.98	1.15	Not Adequately Taught
	Grand Mean	**2.67**	**0.51**	**Taught**

Decision Rule: *Mean ≥ 2.50 = Taught; Mean < 2.50 = Not Adequately Taught*

Table 1 reveals that the grand mean score of 2.67 indicates that entrepreneurial skills are generally taught in the Upper Basic Science curriculum. However, the results show a disparity in emphasis. Skills such as problem-solving (M=3.24), teamwork (M=3.18), creative thinking (M=3.12), and communication (M=3.05) are highly emphasized. Conversely, business-oriented skills like customer service (M=1.98), financial literacy (M=2.15), marketing (M=2.21), and record-keeping (M=2.38) are not adequately taught. This suggests that while generic entrepreneurial competencies are integrated into science teaching, specific business management skills receive insufficient attention.

Research Question 2: To what extent do Upper Basic Science students in Apa LGA acquire entrepreneurial skills?

Table 2: Mean and Standard Deviation of Extent of Entrepreneurial Skills Acquisition

S/N	Skill Statement	Mean	SD	Remark
22	I can solve problems independently using scientific methods	3.15	0.71	High Extent
23	I can work effectively in a team to complete science projects	3.08	0.76	High Extent
21	I can communicate scientific ideas clearly to others	2.95	0.82	High Extent

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026345

27	I can make informed decisions when conducting experiments	2.88	0.79	High Extent
26	I can assess risks and apply safety measures in science activities	2.82	0.85	High Extent
17	I can develop creative solutions to practical science problems	2.76	0.88	High Extent
25	I can manage resources efficiently during practical activities	2.69	0.91	High Extent
16	I can identify business opportunities from my science knowledge	2.58	0.95	High Extent
24	I understand how to maintain quality in producing science-based items	2.52	0.98	High Extent
18	I have acquired skills to produce science-based products	2.46	1.02	Low Extent
20	I have learned how to present and market science-based products	2.35	1.08	Low Extent
28	I have acquired skills to innovate and develop new products	2.31	1.05	Low Extent
19	I can keep simple records of science project activities and expenses	2.24	1.11	Low Extent
29	I understand basic financial concepts related to starting a business	2.08	1.15	Low Extent
30	I can interact professionally with potential customers	1.92	1.18	Low Extent
	Grand Mean	**2.59**	**0.48**	**High Extent**

Decision Rule: *Mean ≥ 2.50 = High Extent; Mean < 2.50 = Low Extent*

Table 2 shows a grand mean of 2.59, indicating that Upper Basic Science students acquire entrepreneurial skills to a high extent overall. However, closer examination reveals that students demonstrate higher acquisition of cognitive and soft skills such as problem-solving (M=3.15), teamwork (M=3.08), and communication (M=2.95). In contrast, practical business skills like customer interaction (M=1.92), financial understanding (M=2.08), record-keeping (M=2.24), and product innovation (M=2.31) are acquired to a low extent. This pattern mirrors the teaching emphasis shown in Research Question 1, suggesting that what is not adequately taught is consequently not well acquired.

Research Question 3: What factors influence the acquisition of entrepreneurial skills among Upper Basic Science students in Apa LGA?

Table 3: Mean and Standard Deviation of Factors Influencing Skills Acquisition

S/N	Factor Statement	Mean	SD	Remark
35	My personal interest and motivation affect my acquisition	3.35	0.65	Influences
33	Practical hands-on activities enhance my acquisition	3.28	0.69	Influences
45	The use of real-life examples by teachers enhances understanding	3.21	0.72	Influences
32	My teacher's teaching methods make it easy to acquire skills	3.14	0.75	Influences
43	Peer influence and group work enhance my development	3.08	0.78	Influences
44	Regular assessment and feedback improve my acquisition	2.95	0.82	Influences

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026345

36	Support from my parents/guardians influences my learning	2.89	0.86	Influences
39	My teacher's competence in entrepreneurship affects acquisition	2.82	0.88	Influences
31	Adequate teaching materials and equipment help me learn better	2.76	0.91	Influences
37	The school environment encourages entrepreneurial skills development	2.68	0.94	Influences
41	Availability of textbooks and reference materials aids learning	2.61	0.97	Influences
38	Access to science laboratories improves my skills acquisition	2.54	1.01	Influences
34	Sufficient time is allocated for entrepreneurial skills training	2.45	1.05	Does Not Influence
40	Field trips and excursions to businesses enhance my learning	2.21	1.12	Does Not Influence
42	Financial constraints limit my ability to practice skills	2.85	0.89	Influences (Negatively)
	Grand Mean	**2.85**	**0.44**	**Influences**

Decision Rule: *Mean ≥ 2.50 = Influences; Mean < 2.50 = Does Not Significantly Influence*

Table 3 indicates that various factors influence entrepreneurial skills acquisition, with a grand mean of 2.85. The most influential factors are student-centered: personal interest and motivation (M=3.35), practical hands-on activities (M=3.28), and use of real-life examples (M=3.21). Teacher-related factors such as teaching methods (M=3.14) and competence (M=2.82) also significantly influence acquisition. However, infrastructural and institutional factors show moderate to low influence. Notably, insufficient time allocation (M=2.45) and limited exposure to real business environments through field trips (M=2.21) do not significantly influence acquisition, likely because these opportunities are rarely provided. Financial constraints (M=2.85) negatively influence skills practice, suggesting that economic barriers impede hands-on application of learned skills.

Discussion of Findings

The findings revealed that although entrepreneurial skills are integrated into the Upper Basic Science curriculum (grand mean = 2.67), their implementation remains uneven. Generic cognitive skills such as problem-solving (M = 3.24), teamwork (M = 3.18), and creative thinking (M = 3.12) received greater instructional emphasis than practical business-oriented skills, including financial literacy (M = 2.15), marketing (M = 2.21), and customer service (M = 1.98). This supports Mbanefo and Eboka's (2021) observation that systemic constraints often weaken the effective implementation of entrepreneurship components in the curriculum. The pattern also aligns with Okezie, Vincent, and Anowor (2013) and Osuala (2009), who reported that entrepreneurship education in Nigeria tends to emphasize theoretical knowledge over practical competence. The imbalance may further reflect the gap between curriculum expectations and labour-market realities noted by Umeh and Eze (2018). Students' overall acquisition of entrepreneurial skills was moderate to high (grand mean = 2.59), with stronger gains in cognitive competencies than in business-specific skills. High acquisition of problem-solving (M = 3.15) and teamwork (M = 3.08) contrasted with weaker mastery of customer interaction (M = 1.92), financial literacy (M = 2.08), and record-keeping (M = 2.24). These findings are consistent with Okezie et al. (2013), who found that students often lack practical business exposure despite entrepreneurship instruction. However, studies such as Usman and Abubakar (2020) and Amadi and Chuku (2021) demonstrate that activity-based and practice-oriented approaches significantly improve entrepreneurial competencies, suggesting that limited practical engagement may explain the

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026345

moderate outcomes observed. The study further identified student motivation (M = 3.35), hands-on activities (M = 3.28), real-life examples (M = 3.21), teaching methods (M = 3.14), and teacher competence (M = 2.82) as significant determinants of skill acquisition. These findings reinforce prior evidence that learner-centered and activity-based pedagogies enhance entrepreneurship outcomes (Mbanefo & Eboka, 2021; Usman & Abubakar, 2020). Financial constraints (M = 2.85) also emerged as a significant barrier, highlighting broader socioeconomic limitations and the need for supportive policy interventions.

Conclusion

Based on the findings of this study, the following conclusions were drawn regarding the state of entrepreneurial skills acquisition among Upper Basic Science students in Apa Local Government Area.

1. Entrepreneurial skills are generally taught at the Upper Basic Science curriculum. However, Skills such as problem-solving, teamwork, creative thinking and communication are highly emphasized. Conversely, business-oriented skills like customer service, financial literacy, marketing, and record-keeping are not adequately taught.
2. Upper Basic Science students acquire entrepreneurial skills to a high extent in Apa Local Government Area.
3. Entrepreneurial skills acquisition is shaped by multiple interacting factors operating at student, teacher, school, and socioeconomic levels.

Recommendations

1. The Benue State Ministry of Education and the NERDC should revise the Basic Science curriculum to include structured modules on financial literacy, marketing, customer relations, business planning, and record-keeping.
2. School administrators and science teachers should intensify practical training by establishing entrepreneurship laboratories or practical spaces where students can engage in product creation.

References

Acs, Z. J., & Audretsch, D. B. (2018). The entrepreneurship research gap. *Economic Journal, 128*(614), 2251–2266. https://doi.org/10.1111/ecoj.12546

Adamu, S., & Yusuf, A. (2022). Integration of entrepreneurial skills in science education: Implications for technological development in Nigeria. *Journal of Science Education and Research, 15*(2), 112–126.

Adebayo, O., & Salami, A. A. (2020). Science education and technological advancement in Nigeria: Challenges and prospects. *International Journal of Education and Research, 8*(4), 45–58.

Adebayo, O., & Yusuf, A. (2022). Enhancing critical thinking through science education: A pathway to technological innovation. *Journal of Educational Research, 14*(3), 210–225.

Adebisi, T. A. (2019). Entrepreneurship education and economic sustainability in Nigeria. *International Journal of Educational Research, 6*(2), 65–74.

Adeyemo, S. A. (2018). Entrepreneurial skills acquisition through science education: A panacea for unemployment in Nigeria. *International Journal of Science Education, 40*(2), 89–103.

Adeyemo, S. A. (2021). Integrating basic science concepts across disciplines: Implications for skill transfer. *Journal of Science Education, 12*(3), 178–190.

Akinyemi, B. O., & Olatunji, A. A. (2020). Gender differences in entrepreneurial skills acquisition among Nigerian secondary school students. *Journal of Science Education and Innovation, 9*(1), 32–41.

Eze, C. U. (2018). Basic science education in Nigeria: Challenges and prospects. *Journal of Educational Research, 10*(2), 87–98.

Eze, C. U. (2021). Entrepreneurial skill acquisition in basic science: A tool for economic empowerment. *International Journal of Educational Studies, 14*(2), 112–124.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026345

Eze, C. U., & Okonkwo, M. N. (2021). Scientific inquiry and entrepreneurial mindset development among upper basic students. *Journal of Science and Technical Education, 13*(4), 210–223.

Ezeani, N. S. (2012). The teacher and skills acquisition at business education: From the perspective of accounting skills. *Arabian Journal of Business and Management Review, 2*(4), 25–34.

Federal Ministry of Education. (2013). *National policy on education* (6th ed.). NERDC Press.

Federal Ministry of Education. (2019). *Implementation guidelines for the Universal Basic Education (UBE) program in Nigeria*. Government Press.

Jegede, S. A. (2016). The relevance of basic science education in the 21st century. *African Journal of Science Education, 8*(3), 145–158.

Mbanefo, E., & Eboka, V. (2021). Acquisition of innovative and entrepreneurial skills in basic science education for job creation in Nigeria. *Nigerian Journal of Educational Research, 15*(3), 210–227.

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. The National Academies Press.

Nwankwo, F. O., & Okafor, C. (2016). Effect of entrepreneurship education on students' entrepreneurial mindset: A study of Nigerian universities. *International Journal of Academic Research in Business and Social Sciences, 6*(3), 1–14.

Nwosu, A. A., & Okeke, E. A. C. (2021). Integration of entrepreneurial skills in upper basic science curriculum: Prospects and challenges. *Journal of Science Teachers Association of Nigeria, 56*(1), 47–59.

Obasi, K. K., & Ojo, P. T. (2020). Entrepreneurship education and self-reliance among Nigerian youths. *International Journal of Educational Management, 18*(2), 222–235.

Obi, C. N. (2019). Entrepreneurship education in Nigerian schools: A pathway to sustainable development. *Nigerian Journal of Business Education, 6*(2), 214–226.

Ogunleye, B. O. (2019). Inquiry-based learning in basic science: Fostering critical thinking skills among Nigerian students. *International Journal of Educational Research, 11*(3), 178–190.

Okezie, A., Vincent, O., & Anowor, O. (2013). Entrepreneurship education and economic development: The Nigerian experience. *Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS), 4*(5), 821–829.

Okebukola, P. A. (2020). Education and sustainable development in Nigeria: Challenges and opportunities. *African Journal of Educational Studies, 12*(1), 1–15.

Olawale, J. A., & Salami, A. A. (2020). Unemployment and entrepreneurship education in Nigeria: The way forward. *International Journal of Educational Research, 12*(2), 87–99.

Olumorin, C. O., Yusuf, M. O., Ajidagba, U. A., & Jekayinfa, A. A. (2018). Entrepreneurship education and students' entrepreneurial skills acquisition in senior secondary schools in Kwara State, Nigeria. *Nigerian Journal of Educational Technology, 4*(1), 93–101.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026346

Effects of Assignment Activities on Attitude and Self-Efficacy in Biological Drawings among Secondary School Students in Sokoto State, Nigeria

ILAH, Hafsat Garba[1]
ilahafsat@gmail..com
+2348068991511

SHAMSUDEEN, Bello[1]
shamsudeen.bello@ssu.edu.ng
+2348032890327

USMAN, Galadima[1]
usman.galadima@ssu.edu.ng
+2348032441317

[1]Department of Science Education, Sokoto State University, Sokoto State, Nigeria

Abstract

This study intends to investigate the effects of School Assignments activities on students' attitude and self-efficacy towards biological drawings in Sokoto State. A pretest post-test quasi-experimental design involving experimental and control group was used to carry out the research. The population of the study was 15, 301 senior secondary school two students in Sokoto State, Nigeria. Multi stage and purposive sampling technique was used to select four schools and 380 students that participated in the study. The treatment lasted for 6 weeks focusing on developing a positive attitude and higher self-efficacy of students through home assignment activities. Biological Drawing Attitude Questionnaire (BDAQ) and Biological Drawing Self-Efficacy Questionnaire (BDSEQ) were administered as instruments. Data obtained from the instruments were analysed using descriptive statistics to answer research questions and Mann Whitney U-test to test hypotheses with the aid of SPSS software. The findings showed that home assignment activities improve students' attitude and self-efficacy among the experimental group. The researcher, recommended among others that teachers should explore the use home assignment as a tool for building students' self-efficacy by allowing repeated practice and independent learning.

Keywords: *Classroom activities, home assignment activities, attitude, self-efficacy and practicing.*

Introduction

Biology is a natural science that studies life and living organisms, it's a subject taught in Senior Secondary Schools in Nigeria and other West African countries across the globe. Biology, the study of life, requires careful observation and description. One excellent way to describe an object is to draw it because drawing encourages careful observation and attention to detail (Flannery, 2017). Drawing is considered to be an important aspect of biology which guides students' understanding of content and processes. It has also become an important tool for many teachers to assess student's understanding about specific biological concepts. Despite its importance, many secondary school students struggle with biological drawing due to limited practice opportunities, lack of confidence and insufficient engagement during lessons. This can reduce students' interest and self-efficacy in drawing and ultimately lead to their failure in answering questions that require drawing skills (Kamar & Bello,2018). There is a unique need of drawing and labelling skills in students of biology because of the variety, complexity and intricacy of the diagram (Debarati & Gowramma, 2017). Drawing in biology is a skill that requires persistent practice in order for learners to perfect in it (Quillin & Thomas, 2015). However, when this practice is neglected in classrooms, students often struggle to develop the required skills in drawing. Although, biological drawing does not require artistic talent,

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026346

many students grapple and lack basic drawing skills, which is a major weakness among Nigerian Secondary School Students as indicated in WAEC chief examiner's report (WAEC, 2023). Sokoto State, like many others across Nigeria, has been faced with decline in students' performance in biology as a result of poor drawing skills (Kamar & Bello, 2018). Conventionally, biological drawings are taught in senior secondary schools in Nigeria using classroom activities where teachers typically draw diagrams on the board or present them from textbooks while students observe and reproduce the drawings in their notebooks during the lesson. Emphasis is often placed on copying the diagrams correctly with little attention given to the drawing process or skill development. As a result, students have minimal opportunities for repeated practice, individualized guidance and corrective feedback. Over time, this may result in poor mastery of biological drawing skills. Furthermore, classroom activities tend to promote passive learning, where students rely heavily on the teacher for instruction and correction. This dependency may limit students' autonomy and reduce their confidence in practicing biological drawings independently. Students who struggle to complete drawings accurately within classroom time may develop anxiety, disinterest, or negative attitudes toward biological drawing tasks. Such experiences can weaken students' belief in their ability to perform drawing tasks successfully, thereby lowering their self-efficacy (Florence, 2019).

Home assignment provides the opportunity to get students to practice and strengthen their drawing skills. It gives the students more time to practice biological drawings compared to classroom activities where time is often limited due to time table schedule, large class size and the need for teachers to cover many topics within a short period of time. It is an expectation for students who complete their home assignment to perform better and to develop higher drawing skills (Williams, Swift, Williams & Van Daal, 2017). This is particularly important in biology, where consistent practice of biological drawings is essential and may lead to improved understanding and growing confidence in the subject. It will also add positive learning habits and attitudes and motivate students to learn on their own, which can produce optimal learning achievement in biology (Utama, Puspasari & Indasari, 2023). The attitude of students towards learning biological drawings plays a major role in engaging in home assignment activities. A student who regularly completes home assignment activities would develop a more positive attitude toward learning biological drawings and this attitude influences the effectiveness of learning as well as student's perceived ability in drawing abilities (Odabas, 2022). The negative attitude often reflected by a student usually results in a lack of interest in drawing biological diagrams. This may make students unable to participate well in any activity that involves drawing in biology. It is generally believed that the attitude of a student towards drawing has a direct bearing on what he/she is able to do or achieve (Florence, 2019). From this, one would infer that students' positive attitude towards learning biological drawing is very essential for positive results. Similarly, students' results based on their positive or negative attitude to home assignment activities, may affect their self-efficacy level. Self-efficacy is particularly important as it directly influences students' attitude towards home assignment. Students with high levels of self-efficacy are more likely to engage in drawing activities by being more diligent in completing their home assignment to achieve higher levels of drawing skills (Cagay, Angelada, Devera & Abelgas, 2024). Unfortunately, students who have low self-efficacy are less likely to enhance their drawing skills or be motivated to engage in learning biological drawings (Sokmen, 2021).

Objectives of the Study

The main objective of this study is to find out whether classroom and home assignment activities can improve students' attitude and self-efficacy towards practicing biological drawings. The specific objectives are to:

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026346

1. Determine the difference in the level of attitude towards biology drawings between secondary school two students exposed to school activities and those taught without school assignment activities in Sokoto State, Nigeria.
2. Find out the difference in the level of self-efficacy towards biology drawings between secondary school two students exposed to school activities and those taught without school assignment activities in Sokoto State, Nigeria.

Research Questions

Based on the objectives of the study, the following research questions were raised for answering:

1. What is the mean difference in the level of attitude towards biology drawings between secondary school two students exposed to school activities and those taught without school assignment activities in Sokoto State, Nigeria?
2. What is the mean difference in the level of self-efficacy towards biology drawings between secondary school two students exposed to school activities and those taught without school assignment activities in Sokoto State, Nigeria?

Null Hypotheses

Based on the research questions in this study, the following null hypotheses were tested:

Ho_1: There is no significant difference in the level of attitude towards biology drawings between secondary school two students exposed to school activities and those taught without school assignment activities in Sokoto State, Nigeria.

Ho_2: There is no significant difference in the level of self-efficacy towards biology drawings between secondary school two students exposed to school activities and those taught without school assignment activities in Sokoto State, Nigeria.

Research Methodology

The research design adopted for this study is pretest post-test quasi-experimental due to the researchers lack of control over the random selection of students from the various secondary schools within the study area. The principals of the four selected secondary schools assigned one intact classroom each to the researcher. Consequently, two classrooms were chosen as the control group, while the remaining two served as the experimental groups. Both groups were taught using the same instructional methods including lecture and demonstration methods. The difference between the groups is in the approach to biological drawing, students in the control group practiced drawing diagrams during the lessons as part of classroom activities whereas students in the experimental group were required to observe diagrams during the lesson and reproduce them at home using textbooks as home assignment activities, the treatment lasted for six weeks and topics taught were cell (plant and animal cells), respiratory system (human and tilapia), reproductive system (human female and reproductive system of plants).

Population of the Study

The population of this study comprises 15, 301 senior secondary school two students from all the senior secondary schools within the six (6) educational zones in Sokoto State during the 2025/2026 academic session. In all, there are one hundred and sixty-eight (168) senior secondary schools in the state.

Sample and Sampling Technique

The sample size from this study consisted of 380 students estimated using Krejcie and Morgan table for sample size estimation. The study adopts multi stage sampling to select four (4) education zones out of six (6) in the state due to insecurity challenges faced in the excluded two (2) zones. Initially, purposive sampling was used to identify four Local Government Areas (LGAs) based on them having

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026346

a relatively stable security. Subsequently four schools were randomly selected from these LGAs providing a representative sample from each zone. Furthermore, one intact class was selected from each of the four (4) schools and the members of these schools constitute the subjects of the study.

Instrumentations

The instruments used in this study were questionnaires titled Biological Drawing Attitude Questionnaire (BDAQ) and Biological Drawing Self-Efficacy Questionnaire (BDSEQ). The BDAQ is divided into two sections. Section A comprises students' bio data while section B has 15 items and is further divided into three (3) parts. Part A, B and C with five (5) items each seeking for the affective, behavioural and cognitive component of attitude in line with the components of attitude. BDSEQ is divided into two parts. Part A is made up of participants demographic data while part B has 13 items with statements that assess participants perceived ability towards biological drawings. Both instruments were validated by experts in the field of biology. Data obtained was analysed using descriptive and inferential statistics. The descriptive statistics involve the mean and standard deviation and they will be presented using tables to answer research questions 1 and 2 to provide a clear and concise summary of the data. Inferential statistics involving Mann Whitney U test was used to answer research hypotheses 1 and 2 to determine whether there is a statistically significant difference between the two groups. Both descriptive and inferential statistics were computed with the aid of SPSS version 21.

Presentation of Results

Data obtained from the BDAQ and BDSEQ were analysed using descriptive statistics and Mann–Whitney U test to test the research questions and null hypotheses at the 0.05 level of significance. The results are presented in line with the study objectives.

Research Question One: What is the mean difference in the level of attitude towards biology drawings between secondary school two students exposed to school activities and those taught without school assignment activities in Sokoto State, Nigeria?

Table 1: Difference in Attitude Between Experimental and Control Group After the Intervention

S/N	Group	N	Median
1	Experimental	188	3.00
2	Control	192	2.00

Table 1 shows the post-intervention attitude scores of the experimental and control groups. The experimental group had a median score of 3.00, while the control group had a median score of 2.00. This shows that the experimental group had a higher attitude toward drawing compared to the control group after the intervention.

Research Question Two: What is the mean difference in the level of self-efficacy towards biology drawings between secondary school two students exposed to school activities and those taught without school assignment activities in Sokoto State, Nigeria?

Table 2: Difference in Self Efficacy Between Experimental and Control Group after the Intervention

S/N	Group	N	Median
1	Experimental	188	3.0000
2	Control	192	1.5385

Table 2 presents the post-intervention self-efficacy scores of the experimental and control groups. The experimental group had a median score of 3.0000, while the control group had a median score

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026346

of 1.5385. This shows that the experimental group had a higher level of self-efficacy compared to the control group after the intervention.

Null hypothesis one (H_{01}): There is no significant difference in the level of attitude towards biology drawings between secondary school two students exposed to school activities and those taught without school assignment activities in Sokoto State, Nigeria.

Table 3: U-test Result of the Attitude of Experimental and Control Group

S/N	Group	N	Z	Mann-Whitney U	P- Value	Decision
1	Experimental	188	-16.87	5.00	0.000	H01 Rejected
2	Control	192				

Table 3 presents the Mann–Whitney U test results comparing students' attitude toward biological drawing in the experimental and control groups. The U-test analysis revealed that u-calculated is 5.00 while p-value is 0.000 which is less than significant value (0.05). The Z-value of -16.87 suggests a strong and statistically meaningful difference between the groups. Since P-value is less than significant value, hypothesis 1 is rejected. Therefore, it indicated there is significant difference between the attitude to drawing of experimental and control groups towards biological diagrams.

Null hypothesis two (H_{02}): There is no significant difference in the level of self-efficacy towards biology drawings between secondary school two students exposed to school activities and those taught without school assignment activities in Sokoto State, Nigeria.

Table 4: U-test Result of Self-Efficacy of Experimental and Control Group

S/N	Group	N	Z	Mann-Whitney U	P- Value	Decision
1	Experimental	188	-16.90	0.00	0.000	H_{02} Rejected
2	Control	192				

Table 4 presents the Mann–Whitney U test results comparing students' self-efficacy toward biological drawing in both groups. The U-test analysis revealed that the U-calculated value is 0.00 while P-value is 0.00 which is less than significance or alpha-value (0.05). The Z-value of -16.90 indicates a strong effect of the intervention and a clear separation between the two groups' rankings. Therefore, the null hypothesis (H_{02}) is rejected indicating a significant difference between the self-efficacy level of experimental and control group towards biological drawing.

Discussion of Findings

This study examined the effectiveness of classroom and home assignment activities on secondary school students' attitude and self-efficacy toward practicing biological drawings in Sokoto State, Nigeria. The findings revealed that students exposed to home assignment activities demonstrated significantly better attitude and higher self-efficacy toward biological drawing compared to those exposed to conventional classroom activities. The significant positive shift in attitude toward drawing among students in the experimental group suggests that engaging in drawing tasks outside the classroom not only builds competence but also improves students' intrinsic motivation and emotional connection. This finding aligns closely with prior empirical research of Florence (2019), emphasizing the influence of structured and supportive learning tasks on student attitudes The finding suggests that home assignment activities had a positive influence on students' attitude toward practicing biological drawings. The improvement in attitude among students in the experimental group may be due to increased opportunities for independent practice, reduced classroom pressure, and the flexibility to engage with drawing tasks at their own pace. These conditions likely enhanced students' interest, motivation, and willingness to engage in biological drawing activities. This finding is consistent with the study of Odabas (2022), who observed that high school students with greater self-efficacy displayed more positive attitudes toward home

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026346

assignments, highlighting the interconnection between confidence in one's abilities and the willingness to engage positively with learning tasks. This suggests that interventions like structured drawing assignments can simultaneously bolster self-efficacy and cultivate favourable learning attitudes. Furthermore, the higher median attitude score observed among students in the experimental group supports the notion that repeated exposure and continuous practice through home assignments promote a more positive attitude toward learning tasks that require skill development, such as biological drawing. When students are given adequate time and independence to practice, they are more likely to develop confidence and a positive mindset toward the drawing task, which enhances their overall learning in biology. The observed increase in self-efficacy among experimental group students after the intervention indicates that home drawing assignments strongly supported students' belief in their ability to draw. This finding implies that home assignment activities contributed meaningfully to strengthening students' belief in their ability to successfully carry out biological drawing tasks. The increased self-efficacy observed among the experimental group may be explained by the mastery experiences gained through repeated practice at home, which is a key source of self-efficacy development. By practicing drawings independently, students were able to monitor their progress, correct errors, and gradually improve their drawing skills, thereby reinforcing their confidence. This finding aligns with Cagay, Angelada, Devera and Abelgas, (2024), who reported that students with higher self-efficacy demonstrate stronger beliefs in their capabilities to handle complex learning tasks. Specifically, empirical work on online homework performance revealed that students who consistently engage with homework demonstrate stronger self-efficacy beliefs as they develop planning, time-management, and reflective learning behaviours, which contribute to increased confidence in their academic abilities (Sokmen, 2021). Overall, the findings of this study highlight the importance of home assignment activities in learning biological drawings. By promoting repeated practice, independent learning and self-regulated learning, home assignments not only improve students' drawing skills but also positively influence their attitude and self-efficacy, ultimately reinforcing their confidence in mastering complex biological concepts.

Conclusion

The results of this study informed the researcher of drawing conclusions that home assignment activities significantly improved secondary school students' attitude and self-efficacy towards practicing biological drawings compared with in-class activities. This suggests that repeated practice through home assignment enhances students' interest, engagement, belief and confidence in their ability to practice biological drawings.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Biology teachers should consistently give students structured home assignment activities to provide them with opportunities for practice, which can foster positive attitudes toward biological drawing and strengthen students' confidence in their drawing abilities.
2. Biology teachers should design home assignment tasks progressively from simple to complex drawings so that students can experience gradual development of drawing skill, thereby promoting favourable attitudes toward drawing tasks and enhancing self-efficacy through repeated mastery experiences.
3. Teachers should deliberately use home assignment activities as a tool for developing both positive learning attitudes and self-efficacy by encouraging independent practice and persistence for learning biological drawings.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026346

4. Teachers should ensure constructive and timely feedback on students' home assignment drawings should be provided to reinforce correct practices, reduce anxiety, and help students develop positive perceptions of their competence in biological drawing.

References

Cagay, J., Angelada, K., Devera, J., and Abelgas, L. (2024). Unraveling The Mediating Influence of Self-Efficacy and Learning Sessions on Students' Performance in Mathematics. *World Journal on Education and Humanities Research, 4*(2), 10–18. ISSN: 2945-4190

Debarati, D., and Gowramma, I. P. (2017). An Analysis of Students' Drawing and Labelling Skills in Science at the Elementary Level. *Indian Educational Review, 55*(2), 108–123. ISSN 0972-561X

Flannery, M. C. (2017). Observations in Biology. *The American Biology Teacher, 69*(9), 561–564. https://doi.org/10.9790/0857-19311219

Florence, A. F. (2019). Teachers' Pedagogical Competence as Determinants of Students' Attitude Towards Basic Science in South West, Nigeria. *Journal of Educational Research and Reviews, 14*(18), 655–660. https://doi.org/10.5897/ERR2019.3761

Kamar, Y. M., and Bello, S. (2018). Improving Drawing Skills of Senior Secondary School Biology Students Through Home-Assignment Method: A Study of Selected Schools in Sokoto South Local Government, Nigeria. *The International Journal of Science and Technology, 6*(2), 118–122. ISSN 2321 – 919X

Odabas, C. (2022). An Analysis About the Relationship Between Online Homework and Perceived Responsibility, Self- Efficacy and Motivation Levels of the students. *Pedagogical Research Journal, 7*(2), 54–62. https://doi.org/10.29333/pr/11887.

Quillin, K. and Thomas, S. (2015). Drawing-to-Learn: A Framework for Using Drawings to Promote Model-Based Reasoning in Biology. *CBE-Life Sciences Education, 14*(1), 1–16. https://doi.org/10.1187/cbe.14-08-0128

Sokmen, Y. (2021). The Role of Self-Efficacy in the Relationship Between Learning Environment and Student's Engagement. *Educational Studies, 47*(1), 19–37.

Utama, L., Puspasari, A., and Indasari, D. (2023). The Effectiveness of the Assignment Method in Civic Education Courses on the Learning Outcomes of Students of the Diploma for Study Program Majoring in Computer Engineering at the Sriwijaya State Polytechnic. *Riwayat: Educational Journal of History and Humantiies, 6*(1), 203–211. https://doi.org/10.2415/jr.v6i1.29582.

West African Examination Council (WAEC). (2023). *Chief Examiner's Report in Biology,Lagos.*

Williams, K., Swift, J., Williams, H. & Van Daal, V. (2017). Raising Children's Self-Efficacy Through Parental Involvement in Homework. *Educational Research Journal, 59*(3), 316–334.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026347

Effects of Think–Pair–Share Instructional Strategy on Interest and Achievement in Ecology Concept among Secondary School Biology Students in Federal Capital Territory, Abuja, Nigeria

DAJAL, R. G.[1]
bobydajal2@gmail.com

AWOYEYE, Agnes O.[2]
awoyeyeagnes@gmail.com

[1]Department of Science and Environmental Education, Yakubu Gowon University, Abuja Nigeria
[2]Institute of Education, Yakubu Gowon University, Abuja Nigeria

Abstract

This study investigating the effect of the Think–Pair–Share (TPS) instructional strategy on secondary school students' interest and achievement in ecological concepts in Biology. The study adopted a quasi-experimental pretest–posttest non-equivalent control group design. A sample of 141 Senior Secondary School One (SS1) Biology students drawn from public secondary schools in the Federal Capital Territory (FCT), Abuja, Nigeria, participated in the study. The experimental group was taught using the TPS instructional strategy, while the control group was exposed to the conventional lecture method. Both groups were taught for five weeks. Ecological Concepts Interest Scale (ECIS) and Ecological Concepts Achievement Test (ECAT) were the instruments used for data collection. Data were analysed using mean, standard deviation, and Analysis of Covariance (ANCOVA). The results showed that students taught using the TPS instructional strategy had higher mean interest and achievement scores than those taught using the conventional teaching method. The study concluded that TPS instructional strategy greatly arouse students' interest and improved their academic performance in ecological concepts. It is therefore recommended that biology teachers adopt the Think–Pair–Share instructional strategy to enhance students' interest and achievement in biology.

Keywords: *achievement, biology, ecological concepts, Interest, Think–Pair–Share,*

Introduction

Biology is the scientific foundation for understanding life and its numerous processes, structures, and relationships. It enables learners to explore how living organisms function, survive, reproduce, and interact within their environments. Among its major branches, ecology occupies a central position because it explains the interconnectedness that exists between organisms and their physical surroundings. Through biology, students gain insight into natural systems and develop an appreciation for the delicate balance that sustains life on Earth. Ecological concepts such as ecosystems, energy flow, nutrient cycling, and population dynamics help learners recognize that no organism exists in isolation. This interconnected perspective strengthens students' scientific literacy and deepens their understanding of environmental stability and sustainability. As a result, biology serves not only as a body of knowledge but also as a tool for developing environmentally conscious and scientifically informed citizens. Ecological concepts are particularly significant because they connect classroom learning to real-world environmental realities that students encounter daily. These concepts help learners understand pressing environmental challenges such as climate change, habitat loss, pollution, and biodiversity decline, which are increasingly evident in many parts of Nigeria. By studying ecological relationships, students become more aware of how human activities influence environmental quality and ecosystem survival. This awareness fosters responsibility and encourages learners to adopt behaviors that support conservation and sustainable resource use. Furthermore, ecological knowledge equips students with analytical and problem-solving skills that are essential for addressing environmental problems at local and global levels. When students fully

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026347

grasp ecological principles, they are better positioned to contribute meaningfully to environmental protection and national development. Therefore, ecological concepts form a critical bridge between biological knowledge and environmental responsibility. Ecology education provides the structured pathway through which ecological concepts are effectively taught and understood within the biology curriculum. It plays a vital role in helping students translate theoretical ecological knowledge into meaningful understanding and practical awareness. However, the effectiveness of ecology education depends largely on the instructional approaches used in the classroom, particularly in secondary schools within the Federal Capital Territory. Traditional lecture-based methods often limit student participation, reducing engagement and weakening conceptual understanding. In contrast, learner-centered strategies such as Think–Pair–Share encourage interaction, collaboration, and active cognitive involvement, which can significantly enhance students' interest and academic achievement. This aligns with the position of UNESCO that effective science education should promote active learning and critical thinking. Reimagining ecology education through innovative instructional strategies is therefore essential for strengthening biology learning outcomes and preparing students to respond effectively to environmental challenges.

Objectives of the Study

To guide the investigation, the study pursued the following objectives:

1. To determine the mean interest scores of students taught Ecology Concept using TPS and those exposed to conventional method in FCT, Abuja
2. To determine the mean achievement scores of students taught Ecology Concept using TPS and those exposed to conventional method in FCT, Abuja

Research Questions

The following research questions guided the study:

1. What is the difference in mean interest scores of students taught Ecology Concept using TPS and those exposed to conventional method in FCT, Abuja?
2. What is the difference in mean achievement scores of students taught Ecology Concept using TPS and those exposed to conventional method in FCT, Abuja?

Null Hypothesis

The following null hypotheses were tested at the 0.05 significance level:

H_{o1}: There is no significant difference in the mean interest scores of students taught Ecology Concept using TPS and those exposed to conventional method in FCT, Abuja

H_{o2}: There is no significant difference in the mean achievement scores of students taught Ecology Concept using TPS and those exposed to conventional method in FCT, Abuja

Literature Review

Biology education plays a fundamental role in developing students' understanding of living systems and their interactions with the environment. Within biology, ecological concepts are essential because they explain how organisms interact with one another and with their physical surroundings, thereby promoting environmental awareness and scientific literacy. However, several studies have reported persistent poor performance and low interest among secondary school students in biology, particularly in ecology-related topics, due to the abstract nature of ecological processes and ineffective teaching approaches (Falilat, 2025; Mohammed et al., 2023). Traditional teacher-centered methods often limit students' active engagement and critical thinking, resulting in superficial understanding and poor retention of ecological knowledge. This has raised serious concerns among educators and researchers, as biology education is expected to equip learners with the knowledge and skills needed to address contemporary environmental challenges. Furthermore, the integration

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026347

of sustainability and environmental literacy into biology education has become increasingly important in preparing students to contribute meaningfully to environmental conservation and sustainable development (Olalekan et al., 2025; Xiong et al., 2025). Therefore, improving ecology education through effective instructional strategies remains a critical priority in science education.

Ecology education specifically focuses on helping learners understand ecosystem structure, energy flow, population dynamics, and environmental interactions. Despite its importance, research indicates that students often experience difficulties in understanding ecological concepts because they are complex and require higher-order thinking skills. Studies have shown that conventional lecture methods promote passive learning, which limits students' opportunities to actively engage with ecological content and construct meaningful understanding (Isa et al., 2020; Mukandayisenga et al., 2021). As a result, students frequently demonstrate low achievement and weak conceptual understanding in ecology. Environmental and biology education researchers emphasize that effective teaching of ecological concepts requires instructional approaches that promote interaction, collaboration, and critical thinking. Student-centered pedagogical strategies have been shown to improve environmental literacy, enhance conceptual understanding, and foster positive attitudes toward biology and environmental sustainability (Xiong et al., 2025; Olalekan et al., 2025). These findings highlight the need for instructional innovations that actively involve students in the learning process and promote deeper understanding of ecological concepts. One such learner-centered approach is the Think–Pair–Share (TPS) instructional strategy, which has been widely recognized for its effectiveness in improving students' academic achievement and interest in biology. TPS encourages students to think independently, discuss ideas with peers, and share their responses with the class, thereby promoting active engagement and collaborative learning. Research conducted in Abuja, Nigeria, revealed that students taught biology using the Think–Pair–Share strategy achieved significantly higher scores compared to those taught using conventional lecture methods, demonstrating its effectiveness in enhancing academic performance (Mbanefo et al., 2023). Similarly, studies have shown that TPS improves students' interest, attitude, and learning outcomes in biology by fostering interaction, critical thinking, and deeper conceptual understanding (Ejigbo et al., 2024; Stella & Gabriel, 2024; Yustini, 2023). TPS has also been found to significantly improve students' understanding of ecological concepts and overall biology learning outcomes (Yawandare et al., 2024). Therefore, the adoption of Think–Pair–Share strategy represents a promising approach for reimagining ecology education and improving students' interest and academic achievement in biology, particularly in secondary schools.

Methodology

This study employed a quasi-experimental pretest–posttest non-equivalent control group design to investigate the effect of the Think–Pair–Share (TPS) instructional strategy on students' interest and achievement in ecological concepts. The population comprised all Senior Secondary School One (SS I) biology students in public secondary schools in the Federal Capital Territory (FCT), Abuja, Nigeria. The sample size was 141 students which were selected from public secondary schools using purposive and simple random sampling techniques. Two instruments used for data collection were; Ecological Concepts Achievement Test (ECAT) and the Ecological Concepts Interest Scale (ECIS). The ECAT contained 40 multiple-choice items designed to measure students' understanding of key ecological concepts, while the ECIS had 20 Likert-scale items used to assess students' level of interest in ecology. The instruments were validated by experts in science and biology education. The instruments were administered as pretest and posttest. To test the reliability coefficient, pilot testing was carried out using 40 students outside the main study sample. The ECAT yielded a Kuder–Richardson (KR-20) reliability coefficient of 0.78, while the ECIS gave a Cronbach's alpha coefficient

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026347

of 0.88, indicating acceptable internal consistency. Before the treatment, biology teachers were guided on how to use the instructional procedures to ensure proper implementation. The experimental group was exposed to Think–Pair–Share instructional strategy. while the control group was taught with conventional lecture method. The treatment lasted for five weeks, after which the posttest was administered. Data were collected and analyzed using mean and standard deviation to answer the research questions, and Analysis of Covariance (ANCOVA) was used to test the hypotheses at the 0.05 level of significance, with pretest scores used to control for initial differences between the groups.

Presentation of Results

Research Question One: What is the difference in mean interest scores of students taught Ecology Concept using TPS and those exposed to conventional method in FCT, Abuja?

Table 1: Mean Interest Scores of Students taught Ecological Concepts using Think-Pair-Share Strategy and Conventional Method

Group	Method of Teaching	N	Mean	Std. Deviation
Experimental Group	Think-Pair-Share	71	4.52	0.637
Control Group	Conventional	70	4.19	0.735
Mean Difference			**0.33**	

Results in Table 1 show the mean interest scores of students taught Ecological Concepts using Think-Pair-Share (TPS) instructional strategy and conventional teaching method. The results revealed that the mean interest score of the students in the experimental group after exposure to TPS strategy was 4.52, while that of their counterparts in the control group was 4.19 with a mean difference of 0.33.

Research Question Two: What is the difference in mean achievement scores of students taught Ecology Concept using TPS and those exposed to conventional method in FCT, Abuja?

Table 2: *Mean Achievement Scores of Students taught Ecological Concepts using Think-Pair-Share Strategy and conventional teaching Method*

Group	Method of Teaching	N	Mean	Std. Deviation
Experimental Group	Think-Pair-Share	71	23.10	4.42
Control Group	Conventional	70	19.73	4.45
Mean Difference			**3.37**	

Results in Table 2 show the mean achievement scores of students taught Ecological Concepts using Think-Pair-Share (TPS) teaching strategy and conventional teaching method. The results revealed that the mean achievement score of the students in the experimental group after exposure to TPS strategy was 23.10, while that of their counterparts in the control group was 19.73 with a mean difference of 3.37.

Test of Hypotheses

Hypothesis One:

There is no significant difference in the mean interest scores of students taught Ecology Concept using TPS and those exposed to conventional method in FCT, Abuja

Table 3: ANCOVA Comparison of the Mean Interest Scores of TPS and Control Groups

Tests of Between-Subjects Effects

Dependent Variable: POST TEST

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026347

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3.539[a]	2	1.769	3.737	0.027
Intercept	138.057	1	138.057	291.57	0
PRETEST	0.461	1	0.461	0.974	0.326
TREATMENT	3.002	1	3.002	6.339	0.013
Error	50.664	107	0.473		
Total	2138.811	110			
Corrected Total	54.203	109			

a. R Squared = 0.065 (Adjusted R Squared = 0.048)
b Computed using alpha = 0.05

Table 3 shows the Analysis of Covariance (ANCOVA) results on students' interest in ecological concepts based on instructional strategy, using pretest scores as covariate. The result revealed that instructional strategy had a statistically significant effect on students' interest, F (1,107) = 6.34, p = .013. Since the p-value (.013) is less than the alpha level of .05, the null hypothesis (H_{01}) was rejected. This indicates that there is a significant difference in the mean interest scores of students taught using the Think–Pair–Share instructional strategy and those taught using the conventional method, in favour of the Think–Pair–Share group

Hypothesis Two:

There is no significant difference in the mean achievement scores of students taught Ecology Concept using TPS and those exposed to conventional method in FCT, Abuja

Table 4: ANCOVA Comparison of the Mean Achievement Scores of TPS and Control Groups

Tests of Between-Subjects Effects

Dependent Variable: POSTTEST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	398.003[a]	2	199.002	10.06	0
Intercept	2778.87	1	2778.87	140.483	0
PRETEST	0.175	1	0.175	0.009	0.925
TREATMENT	302.521	1	302.521	15.294	0
Error	2709.968	137	19.781		
Total	67308	140			
Corrected Total	3107.971	139			

a. R Squared = .128 (Adjusted R Squared = .115)
b. Computed using alpha =.05

The result presented in Table 4 showed a statistically significant difference, F (1,137) = 15.29, p<0.001. Since the p-value is less than the level of significance of α = .05, the null hypothesis was rejected. This indicates that there was a statistically significant difference in the adjusted post-test achievement scores of students taught using the Think–Pair–Share (TPS) strategy and those taught using the conventional method, in favour of the experimental group. This implies that the TPS instructional strategy significantly improved students' achievement in Ecological Concepts compared to the conventional method.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026347

Discussion of Findings

The findings of this study revealed that the Think–Pair–Share (TPS) instructional strategy significantly improved students' interest in ecological concepts compared to the conventional lecture method. Students exposed to TPS demonstrated higher levels of enthusiasm, participation, and willingness to engage in learning activities. This increased interest can be attributed to the interactive nature of TPS, which allows students to actively think about ecological problems, exchange ideas with peers, and confidently share their understanding with the larger group. Such active engagement enhances motivation and promotes deeper emotional and cognitive involvement in the learning process. This finding supports the research question which examined the effect of TPS on students' interest and confirms the corresponding hypothesis that TPS significantly enhances students' interest in ecology. This result is consistent with the findings of Ejigbo et al. (2024) and Stella and Gabriel (2024), who reported that TPS improved students' interest and positive attitude toward biology by creating opportunities for participation and peer interaction. Similarly, Yustini (2023) observed that cooperative learning strategies such as TPS stimulate learners' curiosity and encourage active involvement, thereby strengthening their interest and engagement in biology learning.

Furthermore, the results showed that students taught ecological concepts using the TPS strategy achieved significantly higher academic performance than those taught using the conventional lecture method. This finding indicates that TPS enhances students' understanding of ecological concepts by encouraging active thinking, discussion, clarification of ideas, and immediate feedback. The opportunity to reflect individually, collaborate with peers, and present ideas helps students construct meaningful understanding and correct misconceptions. This supports the research question on the effect of TPS on students' academic achievement and confirms the hypothesis that there is a significant difference in the academic achievement of students taught using TPS and those taught using the lecture method. This finding aligns with Mbanefo et al. (2023), who found that students exposed to TPS performed significantly better than those taught using traditional teaching approaches. Similarly, Yawandare et al. (2024) reported that TPS improved students' conceptual understanding and academic performance in ecological topics. These improvements may be attributed to the student-centered nature of TPS, which promotes active cognitive processing and deeper comprehension compared to passive listening. In addition, the overall findings of this study demonstrated that TPS is more effective than the conventional lecture method in improving both students' interest and academic achievement in ecological concepts. The significant differences observed between the experimental and control groups provide strong evidence that learner-centered instructional strategies can enhance biology education outcomes.

TPS creates a supportive learning environment that encourages collaboration, critical thinking, and knowledge sharing, which are essential for meaningful learning. These findings support the hypothesis that instructional strategy has a significant influence on students' learning outcomes in ecology. This result agrees with the findings of Mohammed et al. (2023), who emphasized that active learning strategies improve students' understanding and academic performance in biology. Similarly, Xiong et al. (2025) noted that interactive teaching approaches promote better learning outcomes, increased engagement, and improved conceptual understanding in science education. Therefore, the findings of this study confirm that Think–Pair–Share strategy is an effective instructional approach for improving students' interest and academic achievement in ecological concepts among secondary school students in the Federal Capital Territory, Abuja.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026347

Conclusion

The study concludes that the Think–Pair–Share instructional strategy is highly effective in enhancing both students' interest and academic achievement in ecological concepts among secondary school students in the Federal Capital Territory, Abuja. Students taught using TPS demonstrated higher engagement, greater motivation, and improved understanding compared to their peers taught with the conventional lecture method. The strategy's collaborative and interactive approach enables students to think critically, discuss ideas with peers, and actively construct knowledge, resulting in meaningful learning and superior academic outcomes. Therefore, integrating TPS into ecology education provides a practical and evidence-based method for improving learning experiences and outcomes in biology, confirming the need for learner-centered instructional strategies in secondary school science education.

Recommendations

The following recommendations were made based on the findings of this research,

1. Teachers of biology, particularly ecology, should integrate the Think–Pair–Share (TPS) instructional strategy into their lessons to enhance students' interest and engagement. Adoption of TPS to Improve Academic Achievement Secondary school biology teachers should adopt TPS as a teaching strategy to improve students' understanding and performance in ecological concepts. The study revealed that students taught with TPS achieved higher mean scores compared to those taught through lectures, demonstrating that active, student-centered learning strategies positively influence academic achievement (Mbanefo et al., 2023; Yawandare et al., 2024).
2. Educational authorities should provide regular training and professional development programs for teachers on implementing TPS and other active learning strategies.
3. Curriculum planners and educational policymakers should revise biology curricula to include and encourage the use of interactive teaching strategies such as TPS, particularly for complex topics like ecology.
4. Further Research on Active Learning Strategies Researchers are encouraged to conduct additional studies on the impact of TPS and other learner-centered approaches on different science topics, across various regions, and at different educational levels.

References

Adeyemi, T. O., & Ajayi, I. A. (2020). Effects of cooperative learning strategies on students' academic achievement in biology. *International Journal of Science Education, 42*(5), 765–780.

Adebayo, F. A., & Oladele, S. O. (2021). Teaching ecology in Nigerian secondary schools: Challenges and prospects. *Journal of Biology Education, 55*(4), 345–356.

Aina, J. K., & Ogunleye, B. O. (2023). Improving students' interest in biology through active learning strategies. *African Journal of Educational Research, 11*(2), 122–134.

Ejigbo, J. O., Agbo, F. O., & Ozoji, B. E. (2024). Effects of think–pair–share strategy on students' attitude towards biology. *International Journal of Innovative Education Research, 12*(3), 217–222.

Garba, A., & Mohammed, U. (2024). Effect of think–pair–share on biology students' achievement. *Journal of Science Education Research, 18*(1), 44–59.

Johnson, D. W., & Johnson, R. T. (2021). Cooperative learning: Improving university instruction. *Educational Researcher, 50*(3), 234–245.

Mbanefo, H. I., Ozoji, B. E., & John, F. J. (2023). Effect of think–pair–share instructional strategy on students' achievement in biology. *Journal of Science Education Research, 9*(2), 45–53.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026347

Mohammed, A., Zakari, B., Bako, I., Isa, A., Abdullahi, M., & Jibrin, Y. (2023). Improving biology learning outcomes using active learning strategies. *International Journal of Research and Innovation in Applied Science, 8*(6), 112–118.

Ogunode, N. J., & Adah, S. (2023). Teaching strategies and students' performance in biology. *African Educational Review, 15*(1), 55–70.

Okeke, S. O., & Nwoye, M. N. (2020). Effects of cooperative learning on students' academic achievement. *International Journal of Educational Research, 8*(2), 112–125.

Okoli, J. N., et al. (2022). Improving science achievement using student-centered strategies. *Journal of Educational Development, 10*(2), 89–103.

Stella, D. G., & Gabriel, G. (2024). Effects of cooperative learning strategies on students' interest in biology. *International Journal of Educational Development, 14*(1), 88–96.

UNESCO. (2021). *Education for sustainable development report.* UNESCO.

Xiong, Z., Song, Y., & Zhu, R. (2025). Pedagogical strategies for improving science learning outcomes. *Sustainability, 17*(20), 9104.

Yawandare, M., Naharia, O., & Manuahe, C. (2024). Improving ecology learning outcomes using think–pair–share strategy. *Journal of Biology Education Research, 11*(1), 34–42.

Yustini, S. (2023). Cooperative learning and biology achievement: The role of think–pair–share. *Biology Education Journal, 3*(1), 50–64.

Yusuf, M. A., et al. (2022). Effects of cooperative learning on students' achievement in biology. *Journal of Educational Studies, 9*(4), 77–91.*

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026348

Effect of Differentiated Instruction on Motivation in Mathematics Concepts among Senior Secondary School Students in Malumfashi Education Zone of Katsina State, Nigeria

DANLAMI, Kazaik Benjamin[1]
bkazaik@gmail.com
08134584954

SANI, Shitu Mohammed[2]
Shitumohammed429@gmail.com

SAID, Jamilu Abdulrahman[3]
Sjamilu39@gmail.com

[1]Department of Science Education, University of Maiduguri, Borno State, Nigeria
[2]Department of General Education, Nuhu Bamali Polytechnic, Zaria, Kaduna State
[3]Department of Science Education, Ahmadu Bello University, Zaria, Kaduna State

Abstract
This study investigated the effect of Differentiated Instruction (DI) on mathematics motivation among senior secondary school students in Malumfashi Education Zone of Katsina state, Nigeria. Motivated learners are more likely to engage, persist, and achieve in mathematics, yet traditional teacher-centered approaches often fail to address individual differences, contributing to disengagement and low motivation. Anchored on Vygotsky's Zone of Proximal Development and Self-Determination Theory, the study employed a quasi-experimental pre-test, post-test control group design. A total of 116 SS2 students from two public co-educational schools in the Malumfashi Education Zone, Katsina State, participated. The experimental group received six weeks of DI through flexible grouping, tiered tasks, and choice-based activities, while the control group received conventional lecture-based instruction. Data were collected using the Mathematics Motivation Scale and analyzed using ANCOVA, controlling for pre-test scores. Results indicated that students exposed to DI had significantly higher post-test motivation scores (M = 85.32, SD = 6.45) compared to the control group (M = 72.18, SD = 7.12), with a large effect size (η^2 = .705). No significant gender differences in motivation were observed within the DI group. Findings suggest that DI effectively enhances mathematics motivation and promotes gender-equitable engagement in resource-constrained classrooms. The study provides practical guidance for teachers, administrators, and policymakers seeking to improve mathematics learning outcomes in northern Nigeria.

Keywords: Differentiated Instruction, Motivation, Mathematics

Introduction
Mathematics is a foundational discipline essential for developing logical reasoning, analytical thinking, and problem-solving skills. It also underpins innovation across science, technology, engineering, and economics. In Nigeria, mathematics is a core subject in senior secondary education and serves as a gateway to higher education and careers in STEM-related fields. Despite its importance, many students perceive mathematics as abstract, complex, and intimidating, contributing to disengagement, low interest, and poor academic outcomes (O. A. Awofala & Fatade, 2023; Ismail et al., 2022). Such challenges limit opportunities for further education and professional development, particularly in regions where educational resources are constrained. In northern

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026348

Nigeria, including Katsina State and the Malumfashi Education Zone, mathematics instruction has traditionally relied on teacher-centered approaches that emphasize uniform content delivery with minimal consideration for individual learner differences (Okpara & Ezeador, 2024). While these methods support curriculum coverage, they often fail to meet diverse student needs, leading to boredom among high-achieving learners and frustration among struggling students (Herner-Patnode & Lee, 2021; Johnson, 2021). Additional contextual challenges, such as large class sizes, limited instructional materials, and socio-economic disadvantages, further exacerbate students' disengagement and demotivation (Salazar & Gumanoy, 2025). These realities underscore the urgent need for instructional strategies that are responsive, flexible, and inclusive.

Differentiated Instruction (DI) has emerged as a promising strategy to address these challenges. DI is a student-centered approach in which teachers tailor content, learning processes, and assessment to students' readiness, interests, and learning profiles (Dhakal, 2024; Tomlinson, 2022). By offering multiple pathways to engage with content, DI fosters motivation, engagement, and self-efficacy. Practical DI strategies include flexible grouping, scaffolded tasks, tiered assignments, and choice-based activities, enabling teachers to support both struggling learners and high achievers. Motivation plays a central role in mathematics learning, influencing students' engagement, persistence, and problem-solving behaviors. Motivated learners actively participate, seek assistance, and persevere through challenges, whereas unmotivated learners may disengage or rely on superficial strategies (Buulolo et al., 2024; Davidovitch & Dorot, 2023). In Nigeria, many secondary students exhibit low intrinsic motivation, prioritizing grades over conceptual understanding or problem-solving skills (Abah et al., 2022; A. O. Awofala et al., 2020). By personalizing learning and providing achievable challenges, DI has the potential to enhance motivation, foster deeper cognitive and emotional engagement, and strengthen students' confidence and resilience (Amoadu et al., 2025; Filgona et al., 2020). Gender is another factor that has attracted considerable attention in mathematics education research. Studies have reported mixed findings regarding gender differences in mathematics motivation and achievement. In some contexts, male students demonstrate higher confidence and interest in mathematics, often attributed to sociocultural expectations, classroom dynamics, and differential encouragement in STEM-related fields (Zakariya, 2022; George & Adu, 2018). However, other studies suggest that when supportive and inclusive instructional strategies are implemented, gender disparities in motivation and engagement tend to diminish (Filgona et al., 2020; Amaro et al., 2021). Student-centered approaches such as Differentiated Instruction may therefore play a critical role in promoting equitable participation by providing learning opportunities that accommodate diverse abilities, interests, and learning styles among both male and female students. Understanding whether DI influences motivation similarly across genders is particularly important in northern Nigerian classrooms, where sociocultural factors may shape students' learning experiences and attitudes toward mathematics. Despite theoretical and empirical support for DI, significant research gaps persist in northern Nigeria. Most studies focus on academic performance or urban southern contexts, offering limited evidence on DI's impact on student motivation in resource-constrained classrooms (Abah et al., 2022; Awofala et al., 2020). Additionally, the potential differential effects of DI on male and female students remain underexplored. To address these gaps, this study investigates the effect of DI on mathematics motivation among senior secondary students in Katsina State, with particular attention to gender differences.

Objectives of the Study

The objectives of the study are to:

1. Examine the influence of differentiated instruction on students' motivation in mathematics.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026348

2. Determine whether male and female students respond differently to differentiated instruction in terms of motivation.

Research Questions

The research questions guiding this investigation are:

1. To what extent does differentiated instruction affect students' motivation in mathematics?
2. Are there gender differences in motivation among students exposed to differentiated instruction?

Theoretical Framework

Understanding how Differentiated Instruction (DI) affects students' motivation in mathematics requires a framework integrating both cognitive and motivational perspectives. This study is anchored on Vygotsky's Zone of Proximal Development (ZPD) and Self-Determination Theory (SDT), which together explain how instruction can be tailored to students' abilities while fostering engagement and persistence.

Vygotsky's Zone of Proximal Development (ZPD)

Vygotsky's ZPD posits that learning occurs most effectively when students engage in tasks slightly beyond their independent capabilities but achievable with appropriate support (Vygotsky, 1978). This concept emphasizes the social and collaborative nature of learning, highlighting the importance of scaffolding from teachers and more knowledgeable peers. In mathematics education, tasks designed within a learner's ZPD challenge students cognitively while providing guidance, enabling gradual mastery and confidence development. Differentiated Instruction operationalizes ZPD by assigning tasks at varying difficulty levels, providing targeted support, and creating flexible learning pathways that address individual strengths and weaknesses. This ensures students are neither bored by tasks that are too easy nor frustrated by those that are too difficult, fostering sustained engagement and cognitive growth (Puntambekar, 2022; Xi & Lantolf, 2021).

Self-Determination Theory (SDT)

While ZPD explains cognitive scaffolding, SDT accounts for motivational processes critical for engagement and persistence (Deci & Ryan, 1985). According to SDT, intrinsic motivation is maximized when students' needs for autonomy, competence, and relatedness are satisfied. In mathematics classrooms, DI supports these needs by offering choice in tasks, aligning challenges with skill levels, and fostering collaborative learning. When these needs are met, students exhibit higher intrinsic motivation, greater persistence, and stronger commitment to mastering mathematical concepts (Filgona et al., 2020; Ryan & Deci, 2020).

Integrating ZPD and SDT with Research Hypotheses

The combination of ZPD and SDT provides a comprehensive lens for understanding how DI influences both cognition and motivation. Tasks aligned with students' readiness promote mastery and confidence (ZPD), while autonomy-supportive and collaborative activities enhance intrinsic motivation (SDT). Grounded in these frameworks, the study hypothesizes that:

Research Hypothesis

H_{O1}: Differentiated instruction has no significant effect on students' mathematics motivation.

H_{O2}: There is no significant difference in mathematics motivation between male and female students exposed to differentiated instruction.

These hypotheses are directly derived from the theoretical expectation that DI, by scaffolding cognitive challenges and supporting intrinsic motivation, will enhance motivation across genders. In practice, DI strategies informed by ZPD and SDT include flexible grouping, tiered assignments, scaffolded tasks, choice-based activities, and collaborative problem-solving exercises. These approaches are designed to challenge students appropriately, foster autonomy and competence, and

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026348

strengthen classroom relationships. By situating DI within these frameworks, the study provides a robust theoretical rationale for investigating its impact on mathematics motivation among senior secondary students in northern Nigeria.

Literature Review

The Concept of Differentiated Instruction

Modern classrooms are marked by remarkable diversity: students differ in academic readiness, learning preferences, interests, cultural backgrounds, and personal circumstances. Traditional "one-size-fits-all" approaches often fail to accommodate these differences, resulting in disengagement, underachievement, and limited access to meaningful learning experiences. In response, Differentiated Instruction (DI) has emerged as a student-centered framework that proactively addresses learner diversity by modifying teaching methods, content, and assessment to meet students' unique needs (Pozas et al., 2021; Tomlinson, 2022). DI is a dynamic approach providing multiple pathways to achieve the same learning objectives. It emphasizes flexibility in content, process, and product, ensuring tasks align with students' readiness, interests, and learning profiles (Shareefa et al., 2019; Tomlinson, 2022). For example, advanced students may tackle complex, open-ended problems, while struggling learners receive scaffolded support to master foundational skills. Differentiation is therefore not about giving more or less work but providing appropriately challenging and meaningful learning experiences that foster engagement and mastery. Central to DI is the teacher's dual role as planner and facilitator. Teachers design varied, student-responsive learning experiences informed by formative assessment, flexible grouping, and scaffolded instruction (Smale-Jacobse et al., 2019; Van Geel et al., 2019). By allowing collaboration based on task, learning profile, or personal preference, DI supports both academic and social development. Student voice and choice further enhance engagement, enabling learners to connect instruction with their interests and take ownership of their learning. DI is an evolving, reflective process, requiring teachers to continuously adjust strategies to meet the changing needs of the classroom (Tomlinson, 2022).

Models of Differentiated Instruction

Several models guide DI implementation. Tomlinson's Model emphasizes differentiation across content, process, and product. Content differentiation involves adjusting material complexity or presentation; process differentiation focuses on how students engage with content, such as through debates, graphic organizers, or hands-on tasks; product differentiation addresses how students demonstrate understanding, such as through essays, presentations, or creative projects. Strategies like tiered assignments, anchor activities, and cooperative learning operationalize these principles, with continuous teacher monitoring and adjustment (Tomlinson, 2022; Van Geel et al., 2019). The DI-Quest Model expands on Tomlinson's framework, integrating teacher beliefs, pedagogical strategies, and classroom practices into a reflective, holistic approach (Coubergs et al., 2017; Griful-Freixenet et al., 2020). It emphasizes proactive planning, adaptive instruction, and flexible grouping. Teachers are encouraged to cultivate a growth mindset and ethical commitment to equitable learning, recognizing that student outcomes reflect the appropriateness of instructional input. The model operationalizes DI through ongoing assessment, reflective practice, and alignment of instruction with student readiness, interests, and learning profiles, thereby promoting engagement and deeper learning.

Motivation in Mathematics Education

Motivation is a key determinant of learning outcomes, reflecting students' willingness to engage and persist in tasks (Amaro et al., 2021; Harris & McDade, 2018; Ray & Sikdar, 2024). In mathematics, motivation is particularly important due to the subject's perceived abstractness and complexity (George & Adu, 2018). It can be intrinsic, driven by interest, curiosity, or personal satisfaction, or

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026348

extrinsic, influenced by grades, recognition, or avoidance of failure (Deci & Ryan, 1985; Zuckerman et al., 2024). Intrinsic motivation fosters deep engagement, problem-solving, and long-term retention, whereas extrinsic motivation supports short-term engagement unless paired with meaningful instruction. Motivational outcomes are influenced by teacher-student interactions, instructional strategies, classroom climate, perceived competence, and content relevance. Techniques such as real-world applications, collaborative problem-solving, and technology-enhanced instruction enhance both intrinsic and extrinsic motivation by making mathematics engaging and relevant (Mahmoud, 2023). Motivation is closely linked to self-efficacy: students who believe in their abilities exhibit greater persistence, while low self-efficacy leads to avoidance and anxiety (Asanre et al., 2024; Özcan & Kültür, 2021; Zakariya, 2022).

Linking Differentiated Instruction and Motivation

DI addresses motivational challenges in mathematics by aligning learning with students' readiness, interests, and learning profiles. By providing scaffolded support, choice, and flexible learning pathways, DI fosters autonomy, competence, and relatedness the key determinants of intrinsic motivation according to Self-Determination Theory (SDT) (Deci & Ryan, 1985; Wong et al., 2023). Flexible and reflective DI ensures appropriate challenge and support, enhancing both engagement and performance. Thus, DI functions as both a pedagogical and motivational strategy, cultivating sustained interest, positive attitudes, and academic growth in mathematics.

Critically, most studies on DI and motivation focus on urban, Western, or Southern Nigerian contexts, often overlooking resource-constrained northern classrooms. Methodological limitations include small sample sizes, reliance on self-reported motivation scales without triangulation, and minimal attention to gender dynamics. These limitations reduce the transferability of findings to contexts such as Katsina State, where large class sizes, resource scarcity, and socio-cultural factors shape instructional feasibility and effectiveness.

Research Gaps and Justification

Despite extensive literature on DI, empirical evidence examining its impact on mathematics motivation in northern Nigeria is limited, particularly in the Malumfashi Education Zone. Few studies simultaneously investigate intrinsic and extrinsic motivational outcomes or consider gender as a moderating factor. Additionally, much of the existing research emphasizes theoretical models or descriptive accounts of DI implementation without measuring concrete student outcomes, leaving a gap in context-specific, evidence-based guidance for teachers. This study addresses these gaps by investigating the effect of DI on mathematics motivation and performance among senior secondary students in Katsina State. By grounding the research in Vygotsky's ZPD and SDT, and employing rigorous empirical methods, the study provides context-specific evidence to inform practice and policy. The findings will bridge the gap between theory, classroom practice, and student outcomes, offering actionable strategies for enhancing motivation and performance in northern Nigerian mathematics classrooms.

Research Methodology

Research Design

This study employed a quantitative quasi-experimental design using a pre-test, post-test control group approach to examine the effect of Differentiated Instruction (DI) on mathematics motivation among Senior Secondary School II (SS2) students in northern Nigeria. A quasi-experimental design was chosen as it enables investigation of causal relationships between instructional strategies and student motivation while preserving the integrity of natural classroom environments (Creswell, 2021).

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026348

The study is grounded in a positivist paradigm, which assumes that student motivation can be objectively measured and analyzed. This perspective aligns with the aim of quantifying the effect of DI on motivation. Intact classes were randomly assigned to either the experimental group, receiving DI tailored to students' abilities, learning preferences, and interests, or the control group, receiving conventional lecture-based instruction.

Population of the Study

The target population comprised all SS2 students enrolled in public co-educational senior secondary schools within the Malumfashi Education Zone, Katsina State, representing a mix of rural and semi-urban contexts. Students were aged 16–17 years and came from diverse ethnic backgrounds, predominantly Hausa and Fulani. Schools follow the national Senior Secondary School Mathematics Curriculum, with class sizes ranging from 30 to 50 students. Mathematics teachers generally hold at least a Bachelor's degree in education with a specialization in mathematics. From the accessible population, two schools were selected through simple random sampling. Within each school, one intact SS2 class was randomly assigned as experimental or control, preserving classroom dynamics and minimizing disruption. The final sample included 116 students (74 males, 42 females), with 62 in the experimental group and 54 in the control group. This sampling ensured comparability between groups and strengthened internal validity.

Instrumentation

The study adopted the Mathematics Motivation Scale (MMS) developed by Zakariya and Massimiliano (2021) to measure secondary school students' motivation in mathematics. The MMS consists of 24 items distributed across five subscales: self-efficacy for learning and performance, intrinsic motivation, utility of mathematics, importance of mathematics, and extrinsic motivation. For this study, minor adaptations were made to align the items with the local curriculum and contextual relevance, including rewording some statements to specifically reference mathematics learning in Nigerian secondary schools. To ensure the validity of the adapted MMS, two mathematics education experts (Ph.D.) reviewed the scale for content and face validity, evaluating items for clarity, relevance, and representativeness of the motivational constructs. Their feedback guided refinements to ensure comprehensive coverage of intrinsic motivation, self-efficacy, task value, and goal orientation. A pilot study with 30 SS2 students from a school outside the main sample further confirmed that items were understandable, culturally appropriate, and aligned with the construct of interest. The scale uses a five-point Likert format, ranging from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating greater motivation. While the original MMS had been validated through exploratory factor analysis (EFA) and demonstrated a clear five-factor structure with high reliability ($\alpha = 0.89$), a full EFA was not conducted for the adapted version. Instead, the internal consistency of the scale and its subscales was assessed in the present study, yielding a Cronbach's alpha of $\alpha = 0.83$, with subscale reliabilities ranging from 0.61 to 0.80. These results confirm that the adapted MMS reliably measures mathematics motivation within the study population.

Intervention

The experimental group received six weeks of differentiated instruction, which involved tailoring content, learning processes, and assessment products to students' readiness levels, interests, and learning preferences. Instructional strategies included flexible grouping, tiered tasks, and choice-based activities to engage students and enhance motivation. The control group received conventional lecture-based instruction covering the same mathematics topics. Both groups were exposed to identical curricular content, and teachers were trained and monitored to ensure consistency in delivery.

Data Collection

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026348

Ethical approval was obtained from the Katsina State Ministry of Education, and school principals provided permission for data collection. Students' participation was voluntary, and informed consent was obtained. Confidentiality and anonymity were ensured throughout the study. Data were collected in three stages: (1) pre-test, where both groups completed the MMS to establish baseline motivation; (2) intervention, with the experimental group receiving differentiated instruction and the control group receiving conventional instruction; and (3) post-test, where the MMS was re-administered to both groups to assess changes in motivation. Test administration took place in classrooms under standardized conditions, supervised by the researcher and mathematics teachers.

Data Analysis

Data were cleaned to remove incomplete responses and checked for errors and outliers. MMS responses were numerically coded, with reverse-coded items appropriately adjusted, and entered into SPSS version 27.0 for analysis. Descriptive statistics, including mean and standard deviation, were computed to summarize motivation scores for the experimental and control groups. To examine the effect of differentiated instruction on students' mathematics motivation, analysis of covariance (ANCOVA) was conducted, controlling for pre-test scores. Assumptions of normality, homogeneity of variance, linearity, and independence were assessed before ANCOVA. Statistical significance was set at $\alpha = 0.05$, and effect sizes were reported to assess the practical impact of the intervention.

Presentation of Results

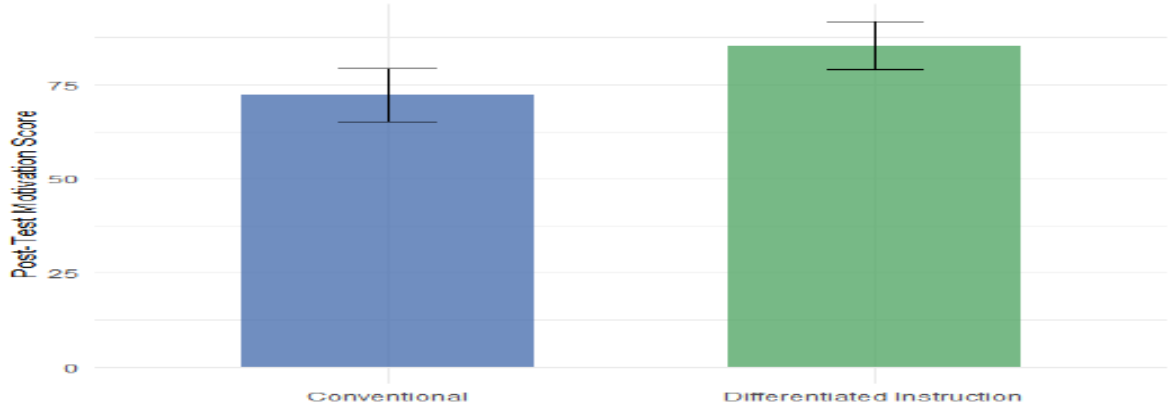
Research Question 1

What is the difference in the motivation levels of students taught mathematics using differentiated instruction compared to conventional teaching methods?

Descriptive statistics were computed to compare post-test motivation scores between students exposed to differentiated instruction and those taught using conventional methods. Students in the differentiated instruction group obtained a higher mean post-test motivation score (M = 85.32, SD = 6.45) compared to students in the conventional teaching group (M = 72.18, SD = 7.12), suggesting that differentiated instruction may enhance student motivation.

Figure 1

Mean Post-Test Motivation Scores by Instructional Group



The graphical representation in Figure 1 indicates that students exposed to differentiated instruction demonstrated higher motivation levels at post-test relative to their counterparts in the conventional group.

Hypothesis One (H01)

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026348

There is no significant difference in the motivation levels of students taught mathematics using differentiated instruction compared to conventional teaching methods.

To test this hypothesis, an Analysis of Covariance (ANCOVA) was conducted with post-test motivation as the dependent variable and pre-test motivation as the covariate to control for baseline differences.

Table 1

ANCOVA Summary for the Effect of Instructional Strategy on Post-Test Motivation

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3759.870[a]	2	1879.935	135.074	.000	.705
Intercept	2023.335	1	2023.335	145.378	.000	.563
Pre_Total	15.478	1	15.478	1.112	.294	.010
Group	3757.267	1	3757.267	269.962	.000	.705
Error	1572.708	113	13.918			
Total	755915.000	116				
Corrected Total	5332.578	115				

a. R Squared = .705 (Adjusted R Squared = .700)

The results in Table 1 show that, after controlling for pre-test motivation scores, there was a significant effect of instructional strategy on students' post-test motivation, $F(1,113) = 269.96$, $p < .001$, $\eta^2 = .705$. This indicates that the differentiated instruction group had significantly higher post-test motivation compared to the conventional teaching group. The covariate (pre-test motivation) did not significantly affect post-test motivation, $F(1,113) = 1.11$, $p = .294$.

Research Question 2

Is there a difference in motivation between male and female students exposed to differentiated instruction?

Descriptive statistics were computed to examine post-test motivation differences between male and female students within the differentiated instruction group. Male students recorded a mean motivation score of (M = 86.12, SD = 6.10), whereas female students obtained a mean score of (M = 84.55, SD = 6.80), indicating a slight difference in favor of male students.

Figure 2

Mean Post-Test Motivation Scores by Gender

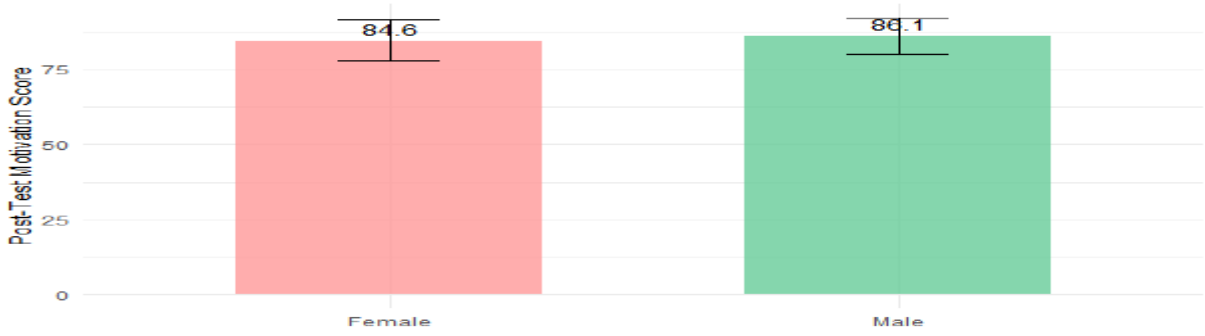


Figure 2 illustrates the distribution of post-test motivation scores across gender within the differentiated instruction group.

Hypothesis Two (H02)

There is no significant difference in motivation between male and female students taught using differentiated instruction.

To test this hypothesis, an Analysis of Covariance (ANCOVA) was conducted with post-test motivation as the dependent variable and pre-test motivation as the covariate to control for baseline differences.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026348

Table 2

ANCOVA Summary Comparing Post-Test Motivation by Gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	132.842[a]	2	66.421	1.443	.240	.025
Intercept	1622.599	1	1622.599	35.262	.000	.238
Pre_Total	.862	1	.862	.019	.891	.000
Gender	130.239	1	130.239	2.830	.095	.024
Error	5199.735	113	46.015			
Total	755915.000	116				
Corrected Total	5332.578	115				

a. R Squared = .025 (Adjusted R Squared = .008)

The results in Table 2 indicate that, after controlling for pre-test motivation, there was no statistically significant difference in post-test motivation between male and female students within the differentiated instruction group, $F(1,113) = 2.83$, $p = .095$, $\eta^2 = .024$. The covariate (pre-test motivation) also had no significant effect, $F(1,113) = 0.02$, $p = .891$.

Discussion of Findings

The present study investigated the effect of differentiated instruction (DI) on mathematics motivation among senior secondary school students in northern Nigeria, with particular attention to overall motivation and gender differences. The findings provide evidence that DI can significantly enhance students' motivational outcomes, aligning with both the theoretical frameworks of Vygotsky's Zone of Proximal Development (ZPD) and Self-Determination Theory (SDT). Results from the first research question revealed that students exposed to DI demonstrated significantly higher post-test motivation scores compared to their peers in the conventional teaching group. This finding supports Hypothesis One, rejecting the null hypothesis that no difference exists between instructional strategies. The large effect size ($\eta^2 = .705$) indicates that DI had a substantial impact on students' motivation, even after controlling for pre-test scores. These findings are consistent with previous studies demonstrating that DI promotes engagement, autonomy, and competence in mathematics learning (Dhakal, 2024; Filgona et al., 2020; Tomlinson, 2022). By providing flexible learning pathways, scaffolded tasks, and opportunities for student choice, DI allows learners to engage with content at an appropriate level of challenge, reducing boredom for advanced students and frustration for those needing additional support. This aligns with Vygotsky's ZPD, which emphasizes that students learn most effectively when tasks are slightly beyond their independent abilities but achievable with guidance. Within DI, teachers operationalize the ZPD by tailoring tasks, providing scaffolding, and offering tiered challenges, thereby enhancing cognitive engagement and motivation. Additionally, DI supports the psychological needs outlined in SDT. The increased post-test motivation observed among students in the experimental group suggests that DI enhanced students' sense of autonomy, competence, and relatedness. Choice-based activities, collaborative problem-solving, and flexible grouping likely fostered a sense of ownership over learning, built confidence in mathematical abilities, and strengthened peer interactions. These mechanisms help explain the observed improvements in motivation, echoing findings from international studies on DI's impact on intrinsic motivation in STEM subjects (Deci & Ryan, 1985; Massaad & Chaker, 2020; Wong et al., 2023). Regarding the second research question, results indicated a small, non-significant difference in post-test motivation between male and female students within the DI group, with males scoring slightly higher on average ($M = 86.12$) than females ($M = 84.55$). ANCOVA results confirmed that the difference was not statistically significant ($F(1,113) = 2.83$, $p = .095$, $\eta^2 = .024$). This finding suggests that DI is equally effective in enhancing motivation for both genders in northern Nigerian classrooms. These results

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026348

are consistent with studies reporting that DI benefits learners regardless of gender when instruction is responsive to individual needs (Coubergs et al., 2017; Pozas et al., 2021). While some prior research has suggested potential gender differences in mathematics motivation, particularly favoring male students (Abah et al., 2022), the present study indicates that a well-implemented DI approach can mitigate such disparities. This finding has important implications for promoting gender equity in mathematics education, demonstrating that inclusive and flexible pedagogical strategies can create equitable learning opportunities in traditionally male-dominated or resource-constrained contexts.

Implications for Practice

The study provides several practical insights for mathematics education in northern Nigeria. First, the strong positive effect of DI on student motivation underscores the importance of moving beyond traditional teacher-centered approaches. Teachers should integrate flexible grouping, tiered tasks, and choice-based activities to foster engagement and sustain interest in mathematics. Second, the negligible gender differences in DI outcomes suggest that inclusive instructional strategies can support equitable learning, reducing disparities that often emerge in conventional classrooms. Third, school administrators and policymakers should provide professional development and resources to facilitate DI implementation, particularly in contexts characterized by large class sizes and limited instructional materials. Finally, the study reinforces the theoretical rationale for DI as a framework grounded in ZPD and SDT. By aligning cognitive challenge with appropriate scaffolding and supporting intrinsic motivation, DI creates conditions for sustained engagement and effective learning. This integration of cognitive and motivational perspectives highlights DI's potential to transform mathematics classrooms into environments that are both academically rigorous and emotionally supportive. In conclusion, the study provides empirical evidence that differentiated instruction significantly enhances mathematics motivation among senior secondary school students in northern Nigeria. DI was effective for both male and female students, suggesting its utility as an inclusive, student-centered strategy. The findings contribute to the growing body of literature on DI in resource-constrained and culturally diverse educational contexts and offer practical guidance for educators seeking to improve engagement and motivation in mathematics. Future research could explore the long-term effects of DI on performance, the interaction between DI and other motivational constructs, and implementation strategies that are scalable across multiple northern Nigerian schools.

Conclusion

This study examined the effect of differentiated instruction (DI) on mathematics motivation among senior secondary school students in northern Nigeria. Findings revealed that students exposed to DI demonstrated significantly higher motivation levels compared to peers taught using conventional methods. The large effect size ($\eta^2 = .705$) indicates that DI substantially enhances students' motivation, supporting the theoretical frameworks of Vygotsky's Zone of Proximal Development and Self-Determination Theory. Furthermore, the study found no significant gender differences in motivational outcomes, suggesting that DI benefits both male and female students equally. These results indicate that differentiated, student-centered instructional strategies can improve engagement and motivation in mathematics while promoting gender equity in classrooms.

Recommendations

Based on the findings, the following recommendations are proposed:

1. Teachers should implement DI strategies such as flexible grouping, scaffolded tasks, and choice-based activities to enhance students' motivation and engagement.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026348

2. School administrators should organize training and workshops to equip mathematics teachers with the skills and resources needed for effective DI practices.
3. Policymakers and curriculum developers should support instructional approaches that address individual student needs, ensuring equitable access to motivating and challenging mathematics learning experiences for all students.

Reference

Abah, J. A., Ogugua, K. K., & Okoh, V. L. (2022). *Impact of Intrinsic Motivation on Junior Secondary School Students' Academic Performance in Mathematics despite Family Background in Ohimini Local Government Area of Benue State, Nigeria.*

Amaro, H., Sanchez, M., Bautista, T., & Cox, R. (2021). Social vulnerabilities for substance use: Stressors, socially toxic environments, and discrimination and racism. *Neuropharmacology*, *188*, 108518.

Amoadu, M., Hagan, J. E., Obeng, P., Agormedah, E. K., Srem-Sai, M., & Schack, T. (2025). Academic Resilience and Motivation as Predictors of Academic Engagement Among Rural and Urban High School Students in Ghana. *Youth*, *5*(1), 11.

Asanre, A., Sondlo, A., & Abiodun, T. (2024). Impact of Interest and Motivation on Academic Achievement of Junior Secondary School Students in Mathematics. *Journal of Mathematics Instruction, Social Research and Opinion*, *3*(3), 275–284.

Awofala, A. O., Lawani, A. O., & Adeyemi, O. A. (2020). Motivation to learning mathematics and gender as correlates of senior secondary school students' performance in mathematics. *Journal of Educational Sciences*, *4*(2), 318–333.

Awofala, O. A., & Fatade, O. A. (2023). Nigerian Students'poor Performance in Mathematics: Who Do We Blame? *Nigerian Online Journal of Educational Sciences and Technology*, *5*(1), 80–91.

Buulolo, M., Zega, Y., & Yakin Niat Telaumbanua, R. N. (2024). *Analysis of Students Motivation and Mathematics Learning Outcomes on the Material Simplifying Algebra.*

Coubergs, C., Struyven, K., Vanthournout, G., & Engels, N. (2017). Measuring teachers' perceptions about differentiated instruction: The DI-Quest instrument and model. *Studies in Educational Evaluation, 53*, 41–54.

Creswell, J. W. (2021). *A concise introduction to mixed methods research*. SAGE publications.

Davidovitch, N., & Dorot, R. (2023). The Effect of Motivation for Learning Among High School Students and Undergraduate Students—A Comparative Study. *International Education Studies, 16*(2), 117.

Deci, E. L., & Ryan, R. M. (1985). The general causality orientations scale: Self-determination in personality. *Journal of Research in Personality*, *19*(2), 109–134.

Dhakal, B. R. (2024). *Differentiated Instruction: Tailoring learning for diverse learners*. Sikshya.

Filgona, J., Sakiyo, J., Gwany, D. M., & Okoronka, A. U. (2020). Motivation in Learning. *Asian Journal of Education and Social Studies*, 16–37.

George, A., & Adu, E. O. (2018). Motivation and attitude of grade nine learners towards mathematics in King Williams Town Education District, South Africa. *Ghana Journal of Development Studies, 15*(1), 135.

Griful-Freixenet, J., Struyven, K., Vantieghem, W., & Gheyssens, E. (2020). Exploring the interrelationship between Universal Design for Learning (UDL) and Differentiated Instruction (DI): A systematic review. *Educational Research Review, 29*, 100306.

Harris, K. M., & McDade, T. W. (2018). The biosocial approach to human development, behavior, and health across the life course. *RSF: The Russell Sage Foundation Journal of the Social Sciences*, *4*(4), 2–26.

Herner-Patnode, L., & Lee, H.-J. (2021). Differentiated Instruction to Teach Mathematics: Through the Lens of Responsive Teaching. *Mathematics Teacher Education and Development, 23*(3), 6–25.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026348

Ismail, N., Garba, A., Osman, S., Ibrahim, N. H., & Bunyamin, M. A. H. (2022). Exploring Teacher Effects on Intensifying and Minimizing Mathematics Anxiety among Students in Sokoto State, Nigeria. *International Journal of Evaluation and Research in Education, 11*(1), 161–171.

Johnson, C. (2021). *Differentiated instruction and student achievement*.

Mahmoud, E. (2023). Practical technology integration into mathematics teaching in elementary education: Instructional design model, teaching strategies, and assessment techniques. *Remittances Review*, *8*(4), 2912–2932.

Massaad, M., & Chaker, L. Y. A. (2020). The Influence of Differentiated Instruction on Lebanese Students' Motivation, Knowledge, and Engagement. *International Journal of English Literature and Social Sciences*, *5*(3), 755–774.

Okpara, G. C., & Ezeador, C. N. (2024). Philosophy of Teaching: Exploring Various Teaching Methods for Improved Education in Nigeria. *Nnadiebube Journal of Philosophy*, *7*(3).

Özcan, B., & Kültür, Y. Z. (2021). The Relationship Between Sources of Mathematics Self-Efficacy and Mathematics Test and Course Achievement in High School Seniors. *Sage Open*, *11*(3), 21582440211040124.

Pozas, M., Letzel, V., Lindner, K.-T., & Schwab, S. (2021). DI (Differentiated Instruction) Does Matter! The Effects of DI on Secondary School Students' Well-Being, Social Inclusion and Academic Self-Concept. *Frontiers in Education*, *6*, 729027.

Puntambekar, S. (2022). Distributed Scaffolding: Scaffolding Students in Classroom Environments. *Educational Psychology Review*, *34*(1), 451–472.

Ray, S., & Sikdar, D. P. (2024). Prospective Teachers' Motivation Towards Learning: A Panoramic Study. *International Journal of Indian Psychology*, *12*(3).

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, *61*, 101860.

Salazar, R. R., & Gumanoy, R. M. (2025). Differentiated Learning Activities: Effects on Students Motivation and Involvement in Teaching Mathematics. *International Journal of Research and Innovation in Social Science*, *IX*(IIIS), 1707–1714.

Shareefa, M., Rohani, H. A. M. Z., Abdullah, N. Z. M., & Jawawi, R. (2019). *Differentiated Instruction: Definition and Challenging Factors Perceived by Teachers*. ResearchGate.

Smale-Jacobse, A. E., Meijer, A., Helms-Lorenz, M., & Maulana, R. (2019). Differentiated Instruction in Secondary Education: A Systematic Review of Research Evidence. *Frontiers in Psychology*, *10*, 2366.

Tomlinson, C. A. (2022). *Everybody's classroom: Differentiating for the shared and unique needs of diverse students*. Teachers College Press.

Van Geel, M., Keuning, T., Frèrejean, J., Dolmans, D., Van Merriënboer, J., & Visscher, A. J. (2019). Capturing the complexity of differentiated instruction. *School Effectiveness and School Improvement, 30*(1), 51–67.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (Vol. 86). Harvard university press.

Wong, B. S., Chue, K. L., Ali, R. B., & Lee, P. (2023). Differentiated instruction: A comparison of motivation and perceived competence between students with high and low readiness levels. *Educational Research for Policy and Practice*, *22*(1), 139–151.

Xi, J., & Lantolf, J. P. (2021). Scaffolding and the zone of proximal development: A problematic relationship. *Journal for the Theory of Social Behaviour*, *51*(1), 25–48.

Zakariya, Y. F. (2022). Improving students' mathematics self-efficacy: A systematic review of intervention studies. *Frontiers in Psychology*, *13*, 986622.

Zakariya, Y. F., & Massimiliano, B. (2021). Development of mathematics motivation scale: A preliminary exploratory study with a focus on secondary school students. *International Journal of Progressive Education,17*(1), 314 -324.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026348

Zuckerman, D., Yablon, Y. B., & Iluz, S. (2024). The Role of Simulation in Exposing Hidden Gender Biases: A Study of Motivational Discourse in Mathematics Education. *Education Sciences*, *14*(11), 1265.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026349

Development and Utilization of Interactive Digital Manual for Academic Engagement and Assessment in General Studies among Undergraduate Students in University of Ilorin, Kwara State, Nigeria

SALMAN, Medinat F.[1]
mfsalman@unilorin.edu.ng
YAHAYA, L. A.[2]
lyahaya@unilorin.edu.ng
ADEDOKUN-SHITTU, Nafisat A.[3]
adedokun.sna@unilorin.edu.ng
BELLO, Muhinat B.[4]
bello.mb@unilorin.edu.ng
OLAITAN, O. L.[5]
olaitan.ol@unilorin.edu.ng
DOMINIC, Olufunmilola. L.[6]
dominic.of@unilorin.edu.ng
OGUNJIMI, M. O. [7]
ogunjimi.mo@unilorin.edu.ng
BOLU-STEVE, Foluke[8]
ATOLAGBE, A. A.[9]
atolagbe.aa@unilorin.edu.ng
ABDULLAHI, M. S.[10]
abdullahi.ms@unilorin.edu.ng
ALABI, Hafsat I.[11]

[1]Department of Science Education, Faculty of Education, University of Ilorin, Kwara State, Nigeria
[2]Department of Counselling Education, Faculty of Education, University of Ilorin, Kwara State, Nigeria
[3]Department of Educational Technology, Faculty of Education, University of Ilorin, Kwara State, Nigeria
[4]Department of Social Sciences Education, Faculty of Education, University of Ilorin, Kwara State, Nigeria
[5]Department of Health Promotion & Environmental Health Education,University of Ilorin, Kwara State, Nigeria
[6]Department of Human Kinetics Education, Faculty of Education, University of Ilorin, Kwara State, Nigeria
[7]Department of Social Sciences Education, Faculty of Education, University of Ilorin, Kwara State, Nigeria
[8]Department of Counselling Education, Faculty of Education, University of Ilorin, Kwara State, Nigeria
[9]Department of Educational Management, Faculty of Education, University of Ilorin, Kwara State, Nigeria
[10]Department of Arts Education, Faculty of Education, University of Ilorin, Kwara State, Nigeria
[11]Department of Science Education, Faculty of Education, University of Ilorin, Kwara State, Nigeria

Keywords: Interactive Digital Manual, General Studies (GNS), Academic Engagement

Introduction

In the evolving landscape of higher education, the integration of digital technologies into teaching and learning has become essential for improving students' academic engagement and performance. At the University of Ilorin, General Studies (GNS) courses remain compulsory for all undergraduates and serve as foundational courses designed to develop critical thinking, communication skills, civic responsibility, and entrepreneurial competence. Despite their importance, evidence suggests that many undergraduates demonstrate low commitment to these courses, as reflected in irregular lecture attendance, limited class participation, poor engagement with assignments, and an overall indifferent attitude toward GNS content. The large enrolment nature of GNS courses, often involving thousands of students across faculties, further contributes to minimal interaction between lecturers and

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026349

students. This situation encourages passive learning and reduces meaningful academic engagement. Research has consistently shown that student engagement, behavioural, emotional, and cognitive, is a strong predictor of academic achievement and persistence (Fredricks et al., 2004; Harbours et al., 2015). When students are actively involved in learning activities, demonstrate interest, and invest effort in academic tasks, learning outcomes significantly improve. However, outdated, inconsistent, or less interactive instructional materials have been identified as major deterrents to effective participation in GNS courses (Bello et al., 2023).

Digital interactivity offers a viable solution to this challenge. Studies such as Adedokun-Shittu et al. (2021) and Wilson and Harris (2021) reveal that interactive digital tools enhance motivation, critical thinking, collaboration, and active participation. Digital pedagogy, which emphasizes the thoughtful integration of multimedia, automated assessments, and interactive learning elements, aligns with the learning preferences of contemporary digital-native students (Tran et al., 2020). Interactive digital platforms also allow for self-paced learning, instant feedback, personalized engagement, and flexible assessment processes, thereby improving both learning experiences and performance outcomes. Given these realities, there is a compelling need to modernize the delivery of GNS content at the University of Ilorin through the development of an Interactive Digital Manual. Such a manual will integrate multimedia resources, interactive exercises, discussion prompts, and automated assessments to foster deeper understanding, improve attendance and participation, and decongest conventional assessment processes. Therefore, this study seeks to develop an Interactive Digital Manual tailored specifically to General Studies courses at the University of Ilorin to enhance undergraduates' academic engagement, improve learning outcomes, and align GNS content delivery with 21st-century educational demands.

Statement of the Problem

The University of Ilorin in Nigeria faces a dual challenge related to the delivery of General Studies content and the overcrowded conditions at its Computer-Based Test (CBT) centres. The students have identified Institutional, lecturer-based, and student-based problems as contributing to their unfavourable disposition toward the course. Among the institutional issues are: an unconducive learning environment, poor infrastructural and teaching facilities, inconsiderate timing, etc. Lecturers' issues include lateness to class, uncontrolled class, poor motivation, unclear class schedule of class, poor teaching approach, and impromptu cancellation of class, among others. Students' causes involve lack of smartphone for a virtual class, the outdated content of the GNS, irrelevant course to their discipline, obsolete contents, peer influence, poor access to the internet, an inconsistent module of delivery, availability of instructional text module, assumption that class attendance and participation is not necessary, overconfidence to pass the despite truancy and non-challant to the course (Bello, 2023). This has made the current General Studies material prove inadequate, lacking the dynamism needed for active engagement and thorough comprehension among students. Simultaneously, the university grapples with a surge in student numbers during assessment periods, causing congestion and logistical strains at its CBT centres. The rigid structure of current assessment practices exacerbates the issue, leading to peak activity periods that further burden these centres. This initiative seeks to tackle these challenges by developing and implementing an Interactive Digital Manual for General Studies. This digital resource not only aims to enhance academic engagement but also serves as a pivotal tool in decongesting the CBT centres through embedded assessment in the digital interactive manual. By leveraging technology to create an immersive learning experience, the project aims to revolutionize the way General Studies content is delivered and assessed. Through the integration of interactive elements and the adoption of flexible

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026349

assessment methodologies, the project aims to decongest CBT centers by redistributing assessment activities across a broader timeframe. This holistic approach intends to address the challenges associated with overcrowded CBT centers while concurrently elevating the overall quality of General Studies education at the University of Ilorin.

Purpose of the study

The main focus of this study was to examine and to develop a student-centered digital manual for improved engagement in GNS courses in Universities in Nigeria. Specifically, the study:

1. Collaborated with students to develop improved GNS content for the digital manual;
2. Conducted a usability test of the interactive digital manual;

Research Questions

1. How can students be effectively involved in the development of improved General Studies (GNS) content for a digital manual in Nigerian universities?
2. What is the effectiveness of the usability testing process for the interactive digital manual in terms of student engagement and usability?

Literature Review

The literature review has been organized around the following subheadings:

Higher Institution and General Studies

The university, as the highest level of education, is not solely for degree acquisition but for intellectual development, research advancement, and societal transformation. Its core mandate includes training minds capable of solving societal problems, promoting research, and ensuring curriculum quality and relevance (Bandele & Olatunji, 2019). This philosophy underpins the establishment of General Studies (GNS), which aims to produce balanced, socially responsible, and employable graduates. In alignment with Sustainable Development Goal 4 (Quality Education), GNS courses broaden students' knowledge beyond their disciplines, enhance communication skills, promote civic awareness, and cultivate critical thinking necessary for national development. The UN 2023 report elucidated that while 86 per cent of individuals use the Internet in countries providing data, many lack the required digital skills to be able to fully benefit from it or avoid its dangers, with communication/collaboration skills being the most prevalent, followed by problem-solving, safety, and content creation. However, recent trends in teaching-learning processes and students' performance in GNS appear to contradict these foundational objectives. The COVID-19 pandemic, prolonged industrial actions, and economic challenges disrupted academic activities and exposed weaknesses in digital readiness, ICT skills, and online engagement. Although institutions adopted online and blended learning approaches, limited digital competence, poor interaction, and inadequate engagement strategies reduced learning effectiveness. Research emphasizes that effective engagement in higher education, whether physical or online, requires behavioural, emotional, and cognitive dimensions supported by meaningful student–student, student–instructor, and student–content interactions (Moore, 1993; Fredricks et al., 2004). Inadequate communication, delayed feedback, weak instructional strategies, and poor technological integration can negatively affect participation and motivation in General Studies courses. Therefore, there is a pressing need to strengthen digital transformation and interactive course delivery to restore the foundational goals of General Studies in higher institutions.

The Rise of Digital Learning

The integration of digital technologies into education has transformed traditional teaching approaches, creating more interactive, flexible, and student-centred learning environments. Digital tools such as e-books, multimedia resources, and interactive platforms enable educators to design materials that accommodate diverse learning styles while enhancing participation and engagement.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026349

In university settings, particularly within General Studies (GNS) courses, digital learning presents significant opportunities to improve content delivery and academic involvement. Interactive digital manuals have gained attention in higher education due to their ability to promote active learning. Studies indicate that features such as quizzes, simulations, embedded multimedia, and instant feedback increase students' engagement, comprehension, and retention of concepts (Smith, 2018; Jones et al., 2019). Unlike traditional print materials, digital manuals support adaptive and personalized learning, allowing students to progress at their own pace and access additional resources where needed (Clark & Mayer, 2017). This fosters a learner-centred environment that accommodates varied academic abilities and preferences. Furthermore, digital manuals enhance accessibility and flexibility by providing 24/7 access to course materials, supporting online and blended learning models (Diaz & Cartnal, 2021). They are also cost-effective and sustainable, as digital formats reduce printing costs and allow for timely content updates (Martin, 2019). Importantly, interactive platforms generate data on student participation and performance, enabling continuous improvement of instructional strategies (Lopez et al., 2022). Immediate feedback and automated assessment features further strengthen learning outcomes by helping students monitor their understanding in real time.

Models of Interactive Digital Manuals

Developing an interactive digital manual for teaching GNS to promote students' academic engagement requires the following paramount components:

1. Dynamic Content for Digital Interactive Manuals
2. Design Principles for Interactive Learning
3. User Experience and Interface Design
4. Interactivity in Digital Learning
5. Gamification and Learning
6. Assessment and Feedback in Digital Manuals
7. Case Studies and Best Practices
8. Challenges and Future Directions

Stages of Developing an Interactive Digital Manual for Teaching General Studies

Developing an interactive digital manual involves the following stages:

1) Needs Assessment: Identify learners' needs, review curriculum requirements, and assess available technology infrastructure.
2) Curriculum Design: Align content with the GNS curriculum, organize into modules, and define clear learning objectives.
3) Interactive Content Planning: Determine suitable interactive elements, design navigation structure, and ensure content is engaging and standards-aligned.
4) Multimedia Development: Create videos, animations, graphics, and ensure accessibility features for diverse learners.
5) Technology Selection: Choose appropriate platforms or LMS tools and ensure compatibility across devices.
6) UI/UX Design and Usability Testing: Develop an intuitive interface and refine it through user feedback.
7) Assessment and Feedback Integration: Embed quizzes and assignments aligned with objectives, and provide mechanisms for instant feedback and self-assessment.
8) Pilot Testing: Test with a small group, collect feedback, and refine the manual.
9) Implementation and Training: Deploy the manual and train instructors and students on its use.
10) Continuous Improvement: Monitor engagement, gather ongoing feedback, and update content

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026349

and features regularly.

By following these stages, educators can create an interactive digital manual for teaching General Studies that aligns with educational standards and provides an engaging learning experience.

Theory of Social Constructionism

Social constructionism is a sociological theory that views knowledge as shaped through social interactions and language rather than as objective truth. Individuals' perceptions and understanding of the world are constructed through communication with peers, lecturers, and institutions. In the context of developing an interactive digital manual for General Studies at the University of Ilorin, this theory is relevant because it highlights how students' attitudes and engagement are socially influenced. The digital manual should therefore promote meaningful interactions, collaboration, and co-construction of knowledge. Moreover, social constructionism recognizes that knowledge is dynamic, suggesting that the digital manual must be adaptable to students' evolving needs and learning preferences. Applying this framework ensures the manual supports collaborative learning and reflects the socially constructed nature of knowledge.

Methodology

Research Design

The study adopted a mixed-method design using a Design and Development Research (DDR) approach to develop the interactive digital manual. Quantitative data were collected through a researcher-designed Google Form survey to gather students' opinions on interactive features for the manual. Qualitative data were obtained through focus group discussions with lecturers and students to refine and improve General Studies (GNS) content.

Instrumentation

Two instruments were used: (1) a researcher-constructed survey titled "Appraisal of General Studies Digital Interactive Course Contents" and (2) the developed interactive digital manual (React App). Open-ended and structured questions were used to collect relevant data on course content and engagement. The instruments were validated by experts in Educational Research and Educational Technology. A pilot test was conducted among 200- and 300-level students, using pre- and post-tests to assess comprehension after interacting with selected modules.

Population and Sample

The population comprised all undergraduates of the University of Ilorin, while the target population included 200- and 300-level students offering GNS courses across seventeen faculties. Using multi-stage sampling (stratified and proportionate techniques), 1,332 students were selected from an estimated population of 24,000, based on a 95% confidence level and 2.5% margin of error. GNS content authors were also engaged through workshops for content review and integration into the digital manual.

Development of the React App

The digital manual was developed using JavaScript and Node.js for backend operations, MySQL for database management, and Bcrypt for secure authentication. OpenAI integration enabled automated question generation. The frontend was built with React, incorporating multimedia features, animations, audio support (text-to-speech), embedded videos, timed assessments, and automated grading. The system allows students to access weekly content, complete assessments, track performance, and submit appeals. Administrators can upload content, monitor results, manage appeals, and regulate student access. The platform was hosted on Truehost servers.

Procedure for Data Collection

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026349

Permission was obtained from relevant faculty authorities before distributing the survey link through student platforms. Ethical considerations were strictly observed.

Procedure for Data Analysis

Quantitative data were analyzed using SPSS (Version 23.0), while qualitative data were analyzed using Atlas. ti (Version 8.0).ti (Version 22.0).

Presentation of Results

Research Question 1: How can students be effectively involved in the development of improved General Studies (GNS) content for a digital manual in Nigerian universities?

To answer this question, the survey results of the need assessment of the level of relevance of contents of GNS 211 and 212 by the students and the need for more relevant contents, 2698 students across all the 16 faculties responded and the data was presented in figure 1 below

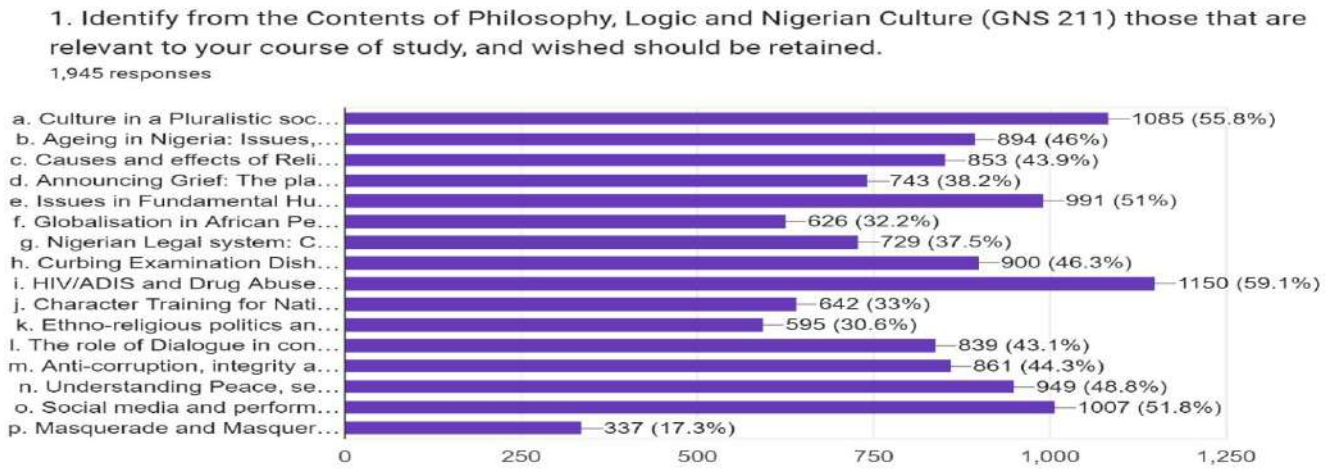


Figure 1: Bar Chart on Students' Response towards GNS 211 contents that are relevant.

From Figure 1 above, the highest percentage response is 59.1%, while the lowest percentage response is 17.3%. The average of all percentage responses is 42.4%. Hence, a benchmark of 40% is used to select the content that is most relevant to the students' course of study and should be retained. Based on this decision, all contents that have above 40% is taken as those relevant to the students' course of study and should be retained. These contents are: HIV/ADIS and Drug Abuse education (59.1%); Culture in a Pluralistic society: A case study of Nigeria (55.8%); Social media and performance of students in Nigeria Tertiary institution (51.8%); Issues in Fundamental Human Rights (51%); Understanding Peace, security and Development (48.8%); Curbing Examination Dishonesty through value education (46.3%); Ageing in Nigeria: Issues, challenges and prospects (46%); Anti-corruption, integrity, and societal development in Nigeria (44.3%); Causes and effects of religious violence in Nigeria (43.9%);The role of Dialogue in conflict resolution (43.1%)

On the other hand, the contents that had below 40% are to be replace meaning that they were not indicated as being relevant to their course of study. These contents are: Announcing Grief: The place of strategies Communication (38.2%); Nigerian Legal System: Concept of Justice and Rule of Law (37.2%); Character Training for National Values: A Religious Consideration (33%); Globalisation in

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026349

African Perspective (32.2%); Ethno-religious politics and political development in Nigeria: A Historical Approach (30.6%); Masquerade and Masquerader: Theatrical Producing for Traditional Cultural Festivals (17.3%). In furtherance of the result of the analysis of students' responses, the following relevant contemporary issues with their contents were indicated as important, which can be used to replace those contents that were not relevant: Bribery and corruption; Business management and Entrepreneurship; Empowerment and Skills acquisition; Human trafficking; Technology and Artificial intelligence; Social interaction, networking and media communication; Culture and Social Changes; Nigeria Rule of law and legal system; Mental health and Emotional Intelligence; Home management and Family life education; Nationalism and Tribalism

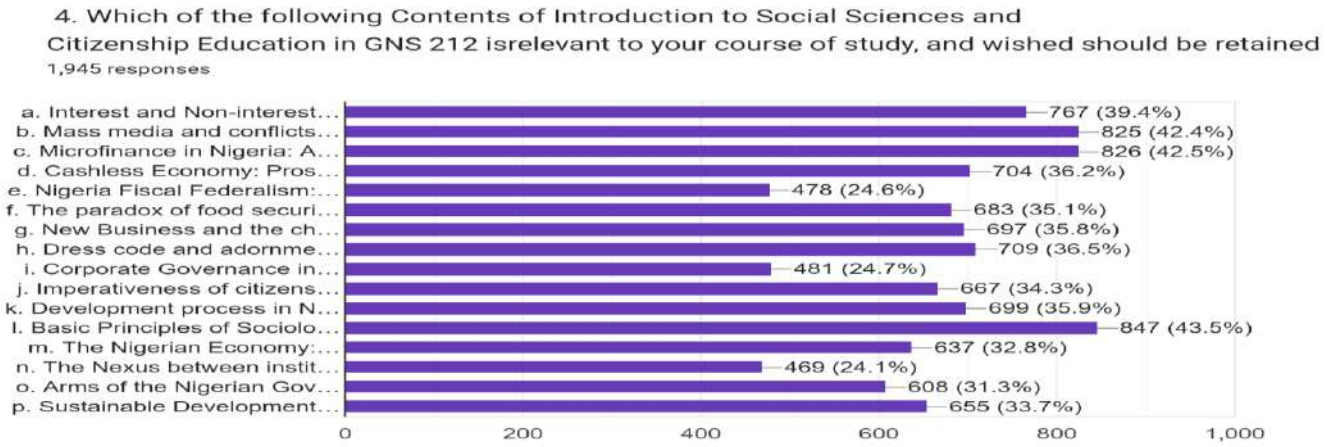


Figure 2: Bar Chart of Students' Responses towards GNS 212 Content that is Relevant.

From Figure 2 above, the highest percentage response is 43.5%, while the lowest is 24.1%. The average of all percentage responses is 34.5%. Hence, a benchmark of 30% is used to select the content that is most relevant to the students' course of study and should be retained. Based on this decision, all contents that have above 30% is taken as those relevant to the students' course of study and should be retained. These contents are: Basic Principles of Sociology and Anthropology (43.5%); Microfinance in Nigeria: An overview (42.5%); Mass media and conflicts in Nigeria (42.4%); Interest and Non-interest Banking: The Issues and the Controversies (39.4%); Dress code and adornment on campuses: issues and challenges (36.5%); Cashless Economy: Prospects and challenges (36.2%); Development process in Nigeria (35.9%); New Business and the challenges of doing Business in Nigeria (35.8%); The paradox of food security in Nigeria (35.1%); Imperativeness of citizenship education to the Nigerian students (34.3%); Sustainable Development in Nigeria: Prospects and Challenges (33.7%); The Nigerian Economy: History and Policies (32.8%); Arms of the Nigerian Government and Constitution of the Federation (31.3%)

On the other hand, the contents that had below 30% are to be replace meaning that they were not indicated as being relevant to their course of study. These contents are: Corporate Governance in Nigeria (24.7%); Nigeria Fiscal Federalism: Lessons of Experience (24.6%); The Nexus between institutions and Corruption: Lessons for Nigeria (24.1%)

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026349

Considering the result of the analysis of students' responses, the following relevant contemporary issues with their contents were indicated as important, which can be used to replace those contents that were not relevant: Human trafficking; Leadership and Management; Inflation and deflation; Youth empowerment; Economic growth and development; Human rights law

Research Question 2: What is the effectiveness of the usability testing process for the interactive digital manual in terms of student engagement and usability?
A usability test was conducted

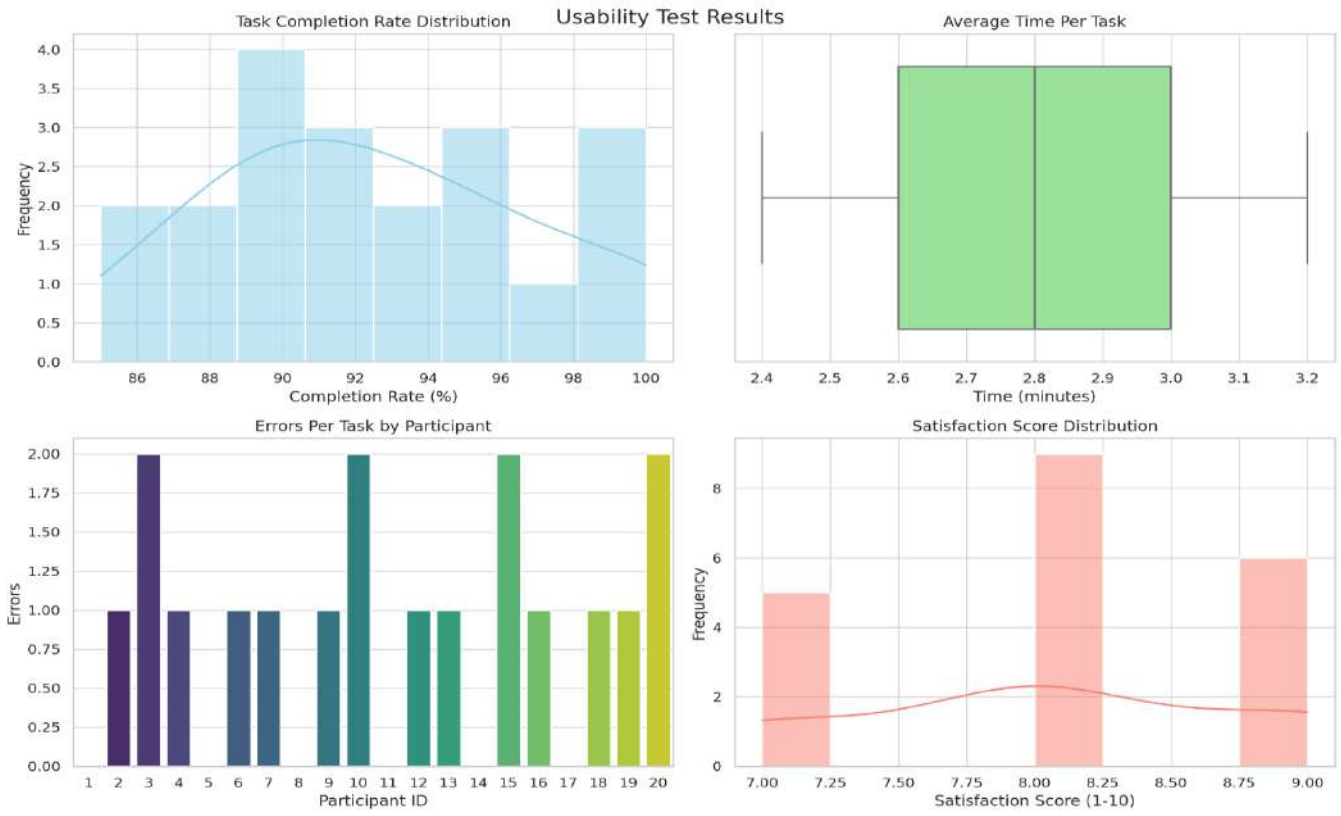


Figure 2: The usability test results:
The usability test of the interactive digital manual developed for undergraduates at the University of Ilorin has provided significant insights into its functionality, user-friendliness, and overall impact on academic engagement. The results indicate that the manual performs well across all measured metrics, showcasing its potential as a valuable educational tool.
Task Completion Rate*:* The manual achieved an average success rate of 92.55%, with many participants attaining 100% completion, demonstrating intuitive design and alignment with user expectations.
Time Efficiency: Tasks were completed within an average of 2.8 minutes (ranging 2.4 to 3.2 minutes), reflecting the manual's clear layout and logical structure.
Error Rate: Minimal errors were recorded, with an average of 0.9 per task, suggesting that the manual guides users effectively and that errors were mostly minor navigation issues.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026349

User Satisfaction: Participants gave an average score of 8.05/10, indicating high satisfaction. Satisfaction was consistent across demographics, confirming the manual's inclusivity and broad appeal. The usability test demonstrated the manual's strong performance in terms of efficiency, accessibility, and engagement. Suggestions for improvement include refining navigation and introducing personalization features to allow adaptive and individualized learning experiences.

Discussion of Findings

The development of the GNS digital manual reflects a significant step in modernizing educational practices. The findings indicate that aligning course content with students' academic and professional aspirations enhances relevance, motivation, and engagement. For example, topics like HIV/AIDS Education and Basic Principles of Sociology and Anthropology were highly valued due to their real-world applicability. Conversely, less relevant traditional content, such as Masquerade and Masquerader, was appropriately replaced with contemporary topics reflecting societal and technological realities, such as AI, Mental Health, and Entrepreneurship. Usability testing underscored the manual's accessibility, interactivity, and intuitive design. High task completion rates, low errors, and strong satisfaction scores confirm its effectiveness as a learning tool. The results align with established usability principles emphasizing simplicity, consistency, and adaptability (Nielsen, 1994; Kearsley & Shneiderman, 1999). Overall, the GNS digital manual enhances educational quality by fostering engagement, inclusivity, and independent learning. It demonstrates how thoughtful integration of technology, content relevance, and user-centered design can address systemic gaps in higher education. Continuous refinement, particularly regarding navigation and personalization, will further strengthen its impact.

Conclusion

The development and adoption of the GNS digital manual demonstrated its transformative potential in addressing key gaps in General Studies education. By aligning content with contemporary issues and emphasizing usability, the manual effectively enhanced student engagement, attendance, and learning outcomes. Students found the manual intuitive and relevant, appreciating its features such as multimedia content, self-assessment tools, and adaptive learning pathways. These innovations promoted active participation, independent learning, and inclusivity, marking a significant step toward modernizing education in Nigeria. While the results were overwhelmingly positive, the findings also highlighted areas for improvement, including enhanced navigation and personalization options. The study underscores the importance of continuous evaluation and adaptation to ensure the long-term success and scalability of such digital interventions.

Recommendations

To ensure the sustained effectiveness, relevance, and scalability of the GNS digital manual, the following recommendations are proposed. These strategies are designed to address identified gaps, build on the manual's successes, and enhance its role in fostering inclusive, engaging, and transformative learning experiences for students in Nigeria and beyond:

1. *Curriculum Realignment:* Replace outdated content with contemporary and relevant topics such as artificial intelligence, mental health, entrepreneurship, and sustainable development to better reflect current societal and professional demands.
2. *Enhanced Interactivity:* Expand interactive features, including gamification and collaborative tools, to further engage students and cater to diverse learning styles.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026349

3. *Customization Options:* Introduce personalization features that allow students to tailor their learning experiences, such as adaptive difficulty levels and user-specific content recommendations.
4. *Regular Feedback Mechanisms:* Implement continuous feedback loops from students and instructors to refine the digital manual based on real-time needs and experiences.
5. *Broader Implementation:* Scale the adoption of the digital manual to other universities in Nigeria, emphasizing its role in fostering sustainable and inclusive education practices.
6. *Monitoring and Evaluation:* Establish a robust monitoring and evaluation framework to assess the manual's long-term impact on learning outcomes, student engagement, and institutional goals.
7. *Technological Updates:* Regularly update the digital manual to incorporate advancements in technology and educational methodologies, ensuring its relevance and effectiveness over time.

References

Chapman, E. (2002). Alternative approaches to assessing student engagement rates. *Practical Assess. Res. Eval.* 8, 1-7.

Fredricks, J A. (2015). Academic engagement. In J. Wright (Ed.), The international encyclopedia of social and behavioral sciences, 2nd edition, Vol. 2 (pp. 31–36). Oxford: Elsevier.

Harbours, K.E., Evanovich,L.L., Sweigart, C.A.& Hughes, L.E. (2015). A brief review of effective teaching practices that maximize student engagement. *Preventing School Failure* 59(1):5-13, DOI: 10.1080/1045988X.2014.91913

Martin, F., & Bolliger, D.U. (2018). engagement matters: student perceptions on the importance of engagement strategies in the online learning environment. *Online Learn.* 22, 205-222. doi:10.1186/s12913-016-1423-5.

Mayer, R. E. (2022). Multimedia learning: Principles that improve classroom instruction. *Educational Psychologist*, 57(2), 121–135.

Smith, A., & Johnson, B. (2019). The impact of interactive digital simulations on student engagement in physics classrooms. *Journal of Science Education,* 25(3), 112-127.

Tran, T. et al. (2020). How digital natives learn and thrive in the digital AGE: Evidence from an emerging economy. *Sustainability*, *12*(9), 3819

United Nations (2023). The Sustainable Development Goals Report: Special Edition-Towards a Rescue Plan for the People and Planet.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026350

Comparative Assessment of WhatsApp and Facebook Social Media Applications Utilization on School Adjustment among Undergraduate Students in Cross River State, Nigeria

BASSEY, Edwin Okpa
edwinbassey@yahoo.com
ebassey@noun.edu.ng
08036700985
National Open University of Nigeria, Uyo Study Centre, Uyo Akwa Ibom State, Nigeria

Abstract

The main purpose of this study was to examine the relationship between utilization of social media and undergraduates school adjustment in public universities in Cross River State, Nigeria. To achieve the purpose of this study two null hypotheses were generated to direct the study. Literature review was done according to the variables under study. Correlational research design was adopted for the study. This design was considered appropriate because it allowed the researcher established the strength and direction between two or more variables. A sample of three hundred and fifty-one (351) respondents was randomly selected for the study. The selection was done through the stratified random sampling technique. The questionnaire was the main instrument used for data collection. The instrument was subjected to face validation by one expert from Education Psychology and two experts in measurement and evaluation in the Faculty of Education, University of Calabar. The reliability estimate of the instrument was established through the Cronbach alpha reliability method. Regression analysis was the statistical analysis technique adopted to test the hypotheses under study. This statistical tool was used because of the nature of the variables involved in the study. All hypotheses were subjected to testing at .05 level of significance with relative degrees of freedom. The results of the analysis revealed that, WhatsApp and Facebook usage significantly relate to undergraduates' school adjustment. Based on the findings of the study it was recommended among others that government should establish WhatsApp study groups for students to facilitate collaborative learning. Instructors can guide the groups and provide moderation to keep discussions focused and productive.

Key words: WhatsApp, Facebook, Social media Application, school adjustment and Students

Introduction

Education serves as a crucial tool for advancing national development and fostering social transformation. It plays a pivotal role in promoting a progressive and cohesive Nigeria. By unlocking the creative potentials and abilities of individuals, education leads to personal fulfilment and contributes to the overall advancement of society. As such, education must be of high quality, all-encompassing, practical, and aligned with the specific demands of the society. According to Federal Republic of Nigeria (FRN, 2014) on National policy on Education stated that, education is the bed rock of any nation, which is the reason for government's investment in education of her citizens. This implies that Education is the key to a nation's `development. For a nation to achieve her educational, scientific, and technological goals her citizens must have skills, aptitude, ability, and creative potential that are necessary for achieving these goals. University education in Nigeria aims to advance the nation's economic growth and global competitiveness by providing accessible and relevant education. It seeks to attract, develop, and graduate competent, knowledgeable, and talented individuals who can contribute to the country's development. However, the transition to university life presents significant challenges for undergraduates, particularly in public universities in Cross River State. Students often encounter academic pressures, social integration issues, and personal development hurdles. Effective school adjustment is crucial, as it enables students to navigate these challenges successfully, leading to improved academic performance and overall well-being. The ultimate goal of school adjustment is to ensure that students thrive in their new academic

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026350

settings, contributing positively to their personal development and that of the overall university community. The role of school adjustment in shaping undergraduates' academic success, social integration, emotional well-being, and overall development throughout their university journey cannot be overemphasized. It is a critical process that enables students to adapt to the academic, social, and emotional demands of their educational environment. In public universities, school adjustment is fundamental for students to achieve academic success, build meaningful relationships, and maintain psychological well-being. However, the process of school adjustment, especially among first-year undergraduates, is fraught with challenges. Many freshmen face significant difficulties transitioning from the structured environment of secondary school to the relatively independent and demanding nature of university life. The new environment presents complex academic expectations, unfamiliar social networks, and the need for greater self-discipline and autonomy. For some students, this transition is smooth; for others, it is a period marked by stress, confusion, and a struggle to find their footing (Tayo, Adebola & Yahya 2019).

School adjustment is the process of adapting to the role of being a student and to various aspects of the school environment. School adjustment encompasses various dimensions, including academic, social, personal/emotional, and behavioural adjustment. Academic adjustment involves a student's ability to meet the intellectual demands of university education, including attending lectures, completing assignments, and managing time effectively. Social adjustment refers to the process of forming new friendships, building peer networks, and engaging with diverse cultural and social dynamics within the university. Personal/emotional adjustment focuses on how students handle the psychological pressures of university life, such as homesickness, anxiety, and maintaining a positive self-concept. Behavioural adjustment is concerned with the alignment of a student's actions and attitudes with the rules, norms, and expectations of the university community. These dimensions are critical for every undergraduate, as they contribute to a holistic educational experience and long-term academic success. Unfortunately, many first-year undergraduates in public universities in Cross River State experience poor adjustment during this critical transition. Freshman are overwhelmed by the sudden shift from a familiar secondary school environment to a new, more challenging academic setting. The pressure to adapt to large class sizes, complex coursework, and demanding lecturers leaves students struggling academically. Socially, freshman find it difficult to establish meaningful friendships or integrate into established peer groups, leading to feelings of loneliness and isolation (Gemmill & Peterson (2016). The consequences of poor school adjustment are far-reaching. For undergraduates, it leads to diminished academic performance, increased dropout rates, and emotional distress. Institutions face challenges such as declining academic standards, disciplinary issues, and reputational harm. At a broader level, the quality of education in the state is compromised, undermining the nation's educational goal of fostering the development of individuals who are intellectually and emotionally equipped to contribute to societal growth. This situation is unacceptable as it undermines the Nigeria's National Policy on Education, which stipulated that education is an instrument for national development that fosters unity, lifelong learning, and self-reliance. Poor school adjustment among students in Cross River State public universities contradicts this objective. While the government and stakeholders have implemented measures such as orientation programs, counseling services, and peer support initiatives to address these challenges, these efforts have yielded limited results. The emotional toll of this transition can also be momentous. Many first-year students grapple with homesickness, fear of failure, and low self-esteem as they strive to find their place in the university. This emotional instability may negatively impact their focus, motivation, and overall mental health. Behavioural issues such as

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026350

procrastination, absenteeism, or even involvement in risky activities may also arise as students struggle to navigate the less structured and more autonomous university environment. Previous studies examined widespread use of social media, basically Facebook (Chia-chen and Brown 2021; Gray, Vitak, Easton & Ellison 2013), but failed to address the multifaceted other social media out fits. Findings suggest the importance of considering connections among personal attributes, perception of media effectiveness and school adjustment. This makes the researcher to suspects the utilization of social media platforms, such as Facebook and WhatsApp may predict undergraduates' school adjustment in public universities in Cross River State, given that these platforms have become integral to students' daily lives, shaping how they communicate, access information, and interact socially. WhatsApp and Facebook are of the most popular social media applications used by young people as a way of communicating with friends, family, strangers and it enables users to have multimedia downloads and text messaging without having to pay (Bhatt & Arshad, 2016). While platforms like WhatsApp and Facebook facilitate instant communication and peer networking, which may promote social adjustment, their excessive use could lead to distractions from academic responsibilities, negatively impacting academic adjustment. Similarly, YouTube, often utilized for educational content, might enhance learning and academic engagement but could also lead to procrastination if used primarily for entertainment. Twitter and Instagram, known for their fast-paced and visually appealing content, may foster social interaction and creativity; however, their overuse might contribute to emotional instability and behavioural issues due to exposure to unrealistic standards or cyberbullying. The dual-edged nature of social media usage raises questions about its role in undergraduates' ability to adapt academically, socially, emotionally, and behaviorally, necessitating a deeper investigation into its overall impact on school adjustment. Institutions and academics are continually exploring social media technologies for collaboration and knowledge construction. Today, social media is used in higher education institutions as a platform where students connect with their instructors, fellow students and other scholars across the globe. The use of social media platforms improves students learning opportunities, fosters collaborative studies and group discussion, allows for communication outside the classroom, and enhances critical thinking. Today, students are exposed to social media platforms on a daily basis; they use desktop computers, laptops, tablets and mobile phones to actively engage in social media platforms for chatting, blogging, content sharing and online learning purpose). Thus, students spend much of their study time on social media rather than in their academic undertakings, diverting their attention from their studies which seems to have an adverse effect on their school adjustment. Despite the peculiarity of social media for learning interaction, not all students use social media platforms for academic purposes.

WhatsApp is one of the most popular social media applications used by young people as a way of communicating with friends, family, strangers and it enables users to have multimedia downloads and text messaging without having to pay (Bhatt & Arshad, 2016). WhatsApp has grown in popularity among adolescents because of its distinctive features of easy communication through text or voice messages, pictures, videos and video calls between two persons or groups, which makes communication easier, faster, cheaper and more enjoyable (Bhatt & Arshad, 2016). Yeboah and Nyagorme (2022) argued that even though WhatsApp is a relatively new social media application, higher education institutions have adopted it for communicating upcoming events and other campus news to students; it facilitates synchronous and asynchronous communication to enhance closer social interactivity, support learning approaches in enhancing creativity, critical thinking, collaborative skills, critical reflection as well as school adjustment. YouTube is a video where

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026350

students are highly involved in the learning process. The teachers' activity is to coordinate and facilitate while students do the work themselves through operation the medium, posting comments where necessary, commenting on other viewers' comments among others. Through this practice, students retain what they have learnt. However, in customized video instructions, teacher operates the video for the students to watch the activities. Learners' works together own their own to solve problem with the assistance of the teacher. This enables them to understand any concept or issues appropriately because it gives them room for exchange of ideas. In contrast with video instructions which is teacher-centered; the students are just viewing and to the medium. (Berk, 2019). Twitter is a free micro-blogging social media website where users communicate with others through tweets/retweets, hashtags, direct messages, favouriting tweets and following other accounts. The platform has more than 300 million users and can be found in nearly every country worldwide. Twitter's concise, short-format post limit of 280 characters (formerly 140), known as tweets. Users post on Twitter for social and professional purposes, such as self-documentation and self-expression (e.g., sharing personal photos/videos/stories), information seeking and sharing (e.g., following news stories, searching for employment, conducting business), social interaction (e.g., connecting with family or friends, meeting new people, professional development, or networking), entertainment (e.g., planning or promoting events, keeping up/connecting with celebrities or local/public figures and organizations), and passing time, among other uses. Users also use Twitter for learning and completing school assignments which enhances school adjustment. The rationale for this study stems from the increasing reliance on social media platforms such as Facebook and WhatsApp among undergraduates and the growing concern about its impact on their school adjustment in public universities in Cross River State, Nigeria. School adjustment, encompassing academic, social, emotional, and behavioural domains, is crucial for undergraduates' success and overall well-being. However, the pervasive use of social media, while offering opportunities for networking, knowledge acquisition, and peer interaction, has raised concerns about its potential to distract, reduce face-to-face interactions, and affect emotional stability. Given the transitional challenges faced by undergraduates, especially first-year students adjusting to a new academic environment, social media can either serve as a supportive tool or exacerbate issues such as academic disengagement, social isolation, and emotional instability. Despite government and institutional efforts to enhance student support systems, the role of social media in influencing these adjustment challenges remains underexplored. The relationship between social media utilization and school adjustment is essential aimed at improving undergraduates' adaptation and performance in public universities. This study is therefore justified by its potential to address these critical gaps and inform strategies to balance the benefits and challenges of social media usage for improved student outcomes. Therefore, the present study investigates utilization of social media and undergraduates' school adjustment in public universities in Cross River State, Nigeria.

Purpose of study

The purpose of this study is to examine the utilization of social media on school adjustment among undergraduate students in public universities in Cross River State, Nigeria. Specifically, the study seeks to:

1. Find out whether Facebook usage predict undergraduates school adjustment in public universities in Cross River State.
2. Investigate whether WhatsApp usage predict undergraduates school adjustment in public universities in Cross River State.

Research questions

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026350

The following research questions were posted to guide the study.

1. To what extent does Facebook usage predict undergraduates' school adjustment in public universities in Cross River State?
2. How does WhatsApp usage predict undergraduates' school adjustment in public universities in Cross River State?

Null hypotheses

The following hypotheses were formulated to guide the study.

1. Facebook usage does not significantly predict undergraduates' school adjustment in public universities in Cross River State.
2. WhatsApp usage does not significantly predict undergraduates' school adjustment in public universities in Cross River State.

Literature Review

Facebook usage and school adjustment

Abbasi, Lashari, Kumar, Khan and Rathore (2021) investigated the impact of facebook on the trends of university students. It was hypothesized that the use of Facebook is a source of entertainment and medium of connecting students. The sample was collected from a public university. There were total forty-six (N= 46) students. Twenty-three (n=23) were female coupled with 23 (n=23) male students of age group 18-25 years. Likert Scale was used for quantifying the results. However, the questionnaire was developed with open-ended and closed-ended queries/statements. The bar charts were developed through illustration of percentage. MS Excel programme was used to further quantify the data. The findings of the study reveal that most of the Facebook users utilize it for communication, information, fun and to be social globally. The study further showed that the use of face book enhances general school adjustment. Chia-chen and Brown (2021) investigated widespread use of social media, especially Facebook, by youth attending college. The study tested a model illuminating pathways linking social competence to college adjustment through students' perceptions about the usefulness of Facebook and ways in which they used the medium. Self-report survey data from 321 college students (M age = 20.09; 58% female; 84% Caucasian) attending a major Midwestern university supported the proposed model, indicating that higher social competence could foster or impede college adjustment, depending upon how it was related to beliefs about the usefulness of different Facebook functions and how these perceptions, in turn, were associated with patterns of Facebook use. Findings underscore the importance of considering connections among personal attributes, perception of media effectiveness and school adjustment.

Gray, Vitak, Easton and Ellison (2013) examined the role Facebook plays in students school adjustment during their first year of college using survey data from 338 students sampled at a private, liberal arts college in the Midwest through simple random sampling technique. the researchers developed and test a model that includes both traditional and Facebook-specific predictors of social support and school adjustment, as well as explore the role that these factors play in predicting student's enrollment status the following year. Results indicate positive relationships between two Facebook variables the number of Facebook friends' students have at the college and their engagement in collaborative behaviours with classmates through the site and measures of social support and school adjustment, as well as a positive relationship between social adjustment and persistence at the university. Perifanou, Tzafilkou and Economides (2021) examined the links between the frequency of social media use, students' digital skills and school adjustment. The survey was conducted with 155 university students in Greece. The instrument on six digital skills components was evaluated in terms of reliability and consistency. The research findings reveal a

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026350

strong positive association between the use of Facebook, Youtube and students' digital skills on content evaluation and protection. Age and gender were related to the frequency of Instagram use. It was concluded that the generic use of Facebook and Instagram does not affect students school adjustment and digital skills.

WhatsApp usage and school adjustment

Lee, Chern and Azmir (2023) investigated the impact of the use of WhatsApp in a higher education learning environment on students perceived academic performance, team effectiveness and school adjustment. A convergent parallel mixed-methods research design was adopted with data collected through a self-administered online survey and two focus group interviews with students of a private university in the Sunway City, Malaysia. The findings of the study present insights into the popularity of WhatsApp among university students and that students use it for social and educational purposes due to its perceived ease of use and usefulness in enhancing academic performance, team effectiveness and school adjustment. Although WhatsApp is recognized as a rich and powerful collaborative tool for students with a positive impact on academic performance, it has a limited impact on the cohesion and openness of team effectiveness. Enaohwo and Awotua-Efebo (2023) investigated students interest on the usage of WhatsApp as a digital learning tool in tertiary institutions in Port Harcourt Metropolis. Two research questions and two null hypotheses guided the study using the descriptive research design. The population of the study was 5315 students in the faculties of education in the two public universities in Rivers State. The sample size was 372 respondents, drawn through stratified random sampling. The Students Interest on WhatsApp Usage Questionnaire (SIWUQ) was used for data collection. Face and content validities were ensured by experts. The reliability coefficient of 0.8 was established through Cronbach alpha. Mean and standard deviation were used to answer the research questions while t-test and one-way ANOVA were used to test the null hypotheses. The study revealed that; students were happy and hence learnt faster using WhatsApp for assignment while they all showed the same level of interest. The study further revealed significant influence of WhatsApp usage on school adjustment. Ahmad (2023) investigated students attitude towards using WhatsApp for educational activities at federal university Dutsin-Ma, Katsina State, Nigeria. The descriptive survey designs was adopted. The population comprised 1,623 undergraduate and postgraduate students, 101 undergraduate and postgraduate students were randomly selected from the different stratified levels of clustered departments. They were derived from the seven faculties of the university. The Researcher developed and used questionnaire as the studys instrument. Three (3) research questions and hypotheses guided the study; while the analytical tools were descriptive statistics in form of mean and standard deviation. Other tools employed were t-test and ANOVA by using SPSS version 23. Findings demonstrated high level of attitude towards WhatsApp among the students. It also showed how the students use the application in various modes to enable them adjust to the school system. Mohammed, Samson and Sadiq (2023) investigated social media usage and school adjustment among students of Federal Colleges of Education, Zaria. The study adopted a survey research design. The target population was nine hundred and eighty-seven (987) male and female students of Federal College of Education, Zaria. The sample of the study was 274 respondents drawn from NCE II students. Data was collected using social media usage questionnaire and school adjustment inventory of the students. The collected data was processed and analyzed using Pearson product moment correlation at a 0.05 level of significance. The study indicated that relationship exist between WhatsApp usage and school adjustment among student with the following values; WhatsApp usage and school adjustment r=0.779, p=.000. facebook and school adjustment r=0.662, p=.000. The study also indicated that relationship exists between Google usage and school adjustment r=0.633, p=0.000. Umar,

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026350

Puspitasari and Hidayati (2023) investigated the influence of undergraduate students WhatsApp using behaviour on teaching/learning process and school adjustment. The study was descriptive qualitative research. The data were collected using interviews, observation and documentation. The data were analyzed using descriptive analysis technique. The result of the research showed that there are positive impact of WhatsApp use on student behaviour as it affects the learning process, students sharing knowledge, student preparation for class, attention, student participation in class, student learning, desires to take additional classes or in subject matter and school adjustment among students. Zulkarnain and Febriyanti (2022) examined the perceptions of pre-service teachers about online learning through the WhatsApp application. Descriptive qualitative method was adopted by using a questionnaire and interview instruments. The questionnaire was given to 74 Elementary School Teacher Education (PGSD) students in the semester 5 of 2020/2021. To validate the data, 5 pre-service teachers were triangulated by conducting in-depth interviews. The analysis technique used was data condensation, presenting data and drawing conclusions. The WhatsApp platform was found to be the best programme to use in online learning on the basis of the study. The research results also showed that the WhatsApp application is the easiest application to use in online learning. The advantages felt by pre-service teachers when learning using the WhatsApp application include; learning to be more flexible, increasing self-confidence, being able to hone skills in making technology-based learning media and being able to obtain information easily and from various sources which enhanced effective school adjustment. Meanwhile, the obstacles felt by pre-service teachers included a lack of concentration in learning, constrained by an unstable network, difficulties in conducting discussions with groups, and difficulty understanding the material as a whole. Al-Mothana (2023) investigated first year university students use of WhatsApp for educational purposes and school adjustment. A cross-sectional study design was followed in which 154 university students completed a questionnaire. The population comprised all second-year students of a public university in Kaduna, Nigeria. Simple random sampling technique was adopted to select 272 students. The results showed that participants had access to smart phones and WhatsApp. The use of WhatsApp was common among participants. Students use WhatsApp for personal and social purposes on a daily basis. However, among the participants, the use of WhatsApp for educational purposes was limited. The participants perceived the integration of WhatsApp into their education to be easy, fun and useful. They had positive feelings and intentions about using WhatsApp in their school adjustment. Yunusa and Bukar (2022) examined the extent of Students usage of WhatsApp instant messenger as a supporting tool for learning in Kaduna State, Nigeria. A survey research design was adopted in the study. Five tertiary institutions were randomly selected based on security guarantee for the study. All final year students in tertiary institutions in Kaduna State formed the population of the study and the stratified random sampling method was used to select a sample of 598 students in exit classes for the study. A structured questionnaire titled; Impact of WhatsApp Instant Messenger on Learning Questionnaire (IWIMOLQ) was used to elicit information from the respondents. 598 copies of the research instrument were administered with the support of five research assistants (who were students in the institutions). The questionnaires were completed and returned within ten weeks. The information collected was coded accordingly into statistical data and analyzed using Mean (M) and Standard Deviation (SD) statistical tools. Mean scores of 2.5 and above (≥2.5) were accepted while mean scores below 2.5 (< 2.5) were rejected. The finding of the study is that students are already familiar with and are using the different WhatsApp features for different purposes, thus making its acceptance and integration as a support tool for learning a seamless process. The study concluded that the usage of WhatsApp and other social networking platforms by students affect their school adjustment. Golam Rabbani Sarker(2015) studied the impact of

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026350

WhatsApp messenger with reference to the students of Begum Rokeya University, Rangpur, Bangladesh in the year. The study was conducted using 200 respondents selected randomly; questionnaire was used as a tool for data collection for the survey. T-test and one-way analysis of variance was used to test the hypotheses under study. The study revealed that WhatsApp has a profound negative impact on students' school adjustment and adversely affects their education, behaviour and routine lives. It messes up much of study time of students and distracts them from completing their assignments. This app has been found to be highly addictive. The study concluded that time management is essential for online activities. Bhatt and M. Arshad (2016) examined the impact of WhatsApp on youths' school adjustment. The survey research method was adopted and data was collected from 100 youth from Agra, India sampled through systematic sampling technique. t-test analysis showed that WhatsApp has positive as well as negative impact on youth. It affects their school adjustment, behaviour and routine lives. It is highly addictive in nature. Findings show that youths are spending more time on this application rather than spending quality time with their family members. Meenakshi and Lakshmi (2023) the impact and the uses of WhatsApp with reference to the students' school adjustment in Vaishnav College for Women Chrompet, Chennai. The exploratory study was conducted on 230 respondents with a structured questionnaire. The data was analysed using SPSS packages. The study concluded that students use of WhatsApp significantly influenced school adjustment among students in the study area.

Research Methodology

The research design used for this study was correlational research design. Correlational research design is a non- experimental research method that examines the relationship between two or more variables without the researcher manipulation or controlling them. The study was carried out in Cross River State. The state is one of the thirty-six (36) states in Nigeria and has 18 local government areas which are divided into three senatorial districts (North, South and Central), officially turned to three education zones (Ogoja, Ikom and Calabar). The state is in the South-South Geo-political Zone of Nigeria and in the Niger Delta region of the country. The State is located within the tropical rainforest of Nigeria and lies between latitudes $5^0$32' and 4^0 27' North of the Equator and longitude 7^0 50' and 9^0 28' East of the Greenwich Meridian (Mofinews, 2006). Cross River State is bounded by Benue State on the North, shares a common boundary with the Republic of Cameroon on the east, on the west by Ebonyi and Abia States, on the South west by Akwa Ibom State, and the Atlantic Ocean. The State has a landmass of about 23,074,425 square kilometer (Cross River State, 2011 Diary). The population of this study comprised all the first-year students in the two public universities in Cross River State which include University of Calabar and University of Cross River State. As at 2023/2024 academic session the population of this set of students stood at 7,020 (Academic Planning Unit &Management Information System, 2023/2024 of the respective Universities). The University of Calabar had a population of 4216 students, being 1833 males and 2383 females. University of Cross River State had a population of 2804 students comprising 1457 males and 1347 females. However, the choice of year one students was based on the assumption that they are the ones who are new and are trying to adapt to new environment. Stratified random sampling technique was adopted for the study. Stratification was based on institutions faculties as well as gender (male and female). The essence of choosing stratified random sampling was to make room for heterogeneous characteristics of the population. A sample of 351 students representing 5% of the entire population of 7020 students from the University of Calabar and University of Cross River State was selected for the study. The instrument that was used for data collection for the study is titled "Utilization of Social Media and Undergraduates School Adjustment Questionnaire (USMUSAQ)". The instrument comprised three sections; section A consisted of demographic variables

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026350

such as institutions, gender and age. Section B contained 12 items measuring sub-variables of the independent variables. Six items measured each of the two variables. Section C consists of 10 questions measuring the dependent variable School adjustment. The instrument was a modified four-point Likert rating scale, ranging from strongly agree, agree, disagree and strongly disagree for positive worded items and the reversed for the scoring were 4,3,2,1 for positively worded items and reversed for negative worded items. This instrument was subjected to face validation. The face validity was established by three experts in measurement and evaluation in the Faculty of Educational Foundations Studies, University of Calabar. To establish the reliability of the instrument, the instrument was trial-tested on 50 respondents selected from University of Uyo who were not part of the sample but had similar characteristics and functions. After the administration and retrieval of the instrument from respondents, the instrument was coded and data subjected to statistical analysis using Cronbach Alpha reliability coefficient. The reliability coefficients ranged from .70 to .88 which showed that the instruments consistent in measuring what they were purported to measure. The researcher presents a letter of introduction to the school authority seeking permission to carry the study. The questionnaire tagged "Utilization of social media and Undergraduates School AdjustmentQuestionnaire (USMUSAQ) was the instruments used for data collection. The questionnaire was administered personally by the researcher with the help of two Research Assistant the same time in each of the sampled institution. The respondents were informed of the exercise. They were told to be honest in their responses to the items as the information obtained would be treated with confidentiality and used as data for the research only.

Presentation of Results

In this section each hypothesis is re-stated, and the result of data analysis carried out to test it is presented. Each hypothesis of the study was tested at .05 level of significance.

Hypothesis one:

Facebook usage does not significantly predict undergraduates' students school adjustment.

The independent variable in this hypothesis is Facebook usage; while the dependent variable is undergraduates' school adjustment. Simple linear regression analysis was employed to test this hypothesis. The result of the analysis is presented in Table1.

Table 1: Simple linear regression results of the relationship between Facebook usage and undergraduates' school adjustment

Model	R	R. square	Adjusted R. Square	Std error of the estimate		
1	.893(a)	.797	.796	1.28596		
Model	Sum of square	df	Mean square	F	p-value	
Regression	2265.570	1	2265.570	1370.012	.000	
Residual	577.137	349	1.654			
Total	2842.707	350				
Variables	Unstandardized regression weight B		Standardized regression weight	Beta weight	t	p-value
(Constant)	5.321		.828		6.426	.000
Facebook usage	1.421		.038	.893	37.014	.000

* Significant at .05 level.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026350

The simple linear regression analysis of the relationship between Facebook usage on the undergraduates' school adjustment yielded a coefficient of multiple regression (R) of.893 and a multiple regression R-square (R2) of .797 and an adjusted R2 of .796. The adjusted R2 of .796 indicated that the facebook usage accounted for 79.6% of the variance in undergraduates' school adjustment in the study area. This finding is a critical indication that Facebook usage is relatively high in the area of the study. The F-value of the Analysis of Variance (ANOVA) obtained from the regression table was F = 1370.012 and the sig. value of .000 (or p<.05) at the degree of freedom (df) 1 and 349. The implication of this result is that Facebook usage is significantly related to undergraduates' school adjustment. The identified equation to understand this relationship was that undergraduates' school adjustment = 5.321+ 1.421 (Facebook usage).

Hypothesis two

There is no significant relationship between WhatsApp usage and undergraduate students school adjustment.

The independent variable in this hypothesis is WhatsApp usage; while the dependent variable is undergraduates' school adjustment. Simple linear regression analysis was the employed to test this hypothesis. The result of the analysis is presented in Table 2.

Table 2: Simple regression results of the relationship between WhatsApp usage and undergraduate students school adjustment

Model	R	R. square	Adjusted R. square	Std error of the estimate		
1	.989(a)	.979	.979	.41272		
Model	Sum of square	df	Mean square	F	p-value	
Regression	2783.260	1	2783.260	16339.961	.000(a)	
Residual	59.447	349	.170			
Total	2842.707	350				
Variables	Unstandardized regression weight B		Standardized regression weight	Beta weight	t	p-value
(Constant)	-2.405		.300		-8.011	.000
WhatsApp usage	1.777		.014	.989	127.828	.000

* Significant at .05 level.

The simple regression analysis of the relationship between WhatsApp usage on the undergraduates' school adjustment yielded a coefficient of multiple regression (R) of .989 and a multiple regression R-square (R2) of .979 and an adjusted R2 of .979. The adjusted R2 of .979 indicated that the WhatsApp usages account for 97.9% of the variance in undergraduates' school adjustment in the study area. This finding is a critical indication that WhatsApp usages are relatively high in the area of the study. The F-value of the Analysis of Variance (ANOVA) obtained from the regression table was F = 16339.961 and the sig. value of .000 (or p<.05) at the degree of freedom (df) 1 and 349. The implication of this result is that WhatsApp usage significantly relates to undergraduates' school adjustment. The identified equation to understand this relationship was that undergraduates' school adjustment = -2.405 + 1.777 (WhatsApp usage).

Discussion of Findings

The result of the first hypothesis implies that there is a relationship or connection between undergraduate use of Facebook and their ability to cope with university life constant use of Facebook may enhance their social network of friends, within the digital space, who they can communicate with academic ally and exchange ideas. This positive attribute will enhance their self-worth, acceptance among peers, build confidence etc. make them well-adjusted in the university.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026350

Abbasi, Lashari, Kumar, Khan and Rathore (2021) who revealed that most of the Facebook users utilize it for communication, information, fun and to be social globally. The study further showed that the use of face book enhances general school adjustment. Chia-chen and Brown (2021) also indicated that higher social competence could foster or impede college adjustment, depending upon how it was related to beliefs about the usefulness of different Facebook functions and how these perceptions, in turn, were associated with patterns of Facebook use. Findings underscore the importance of considering connections among personal attributes, perception of media effectiveness and school adjustment. Gray, Vitak, Easton and Ellison (2013) also indicated positive relationships between two Facebook variables the number of Facebook friends' students have at the college and their engagement in collaborative behaviours with classmates through the site and measures of social support and school adjustment, as well as a positive relationship between social adjustment and persistence at the university. Perifanou, Tzafilkou and Economides (2021) also revealed a strong positive association between the use of Facebook, YouTube and students' digital skills on content evaluation and protection.

The result of this study has showed that the utilization of social media significantly predicts undergraduate school adjustment in various areas which means that WhatsApp allows student maintain social communication, share information and also promote collaboration of project work which can ease school adjustment in an academic environment. The result of this finding has also help to bridge the gap for students who find it difficult to communicate(introvert) or attend physical meetings, also as a valuable tool for student to seek for help from their peers or instructors, especially those who may not feel comfortable approaching them in person, it helps to keep student informed and organized. The finding of this hypothesis is in line with the view of Lee, Chern and Azmir (2023) who findings of the study present insights into the popularity of WhatsApp among university students and that students use it for social and educational purposes due to its perceived ease of use and usefulness in enhancing academic performance, team effectiveness and school adjustment. Although WhatsApp is recognized as a rich and powerful collaborative tool for students with a positive impact on academic performance, it has a limited impact on the cohesion and openness of team effectiveness. Enaohwo and Awotua-Efebo (2023) also revealed that students were happy and hence learnt faster using whatsapp for assignment while they all showed the same level of interest. The study further revealed significant influence of whatsapp usage on school adjustment. Ahmad (2023) also demonstrated high level of attitude towards WhatsApp among the students. It also showed how the students use the application in various modes to enable them adjust to the school system. Mohammed, Samson and Sadiq (2023) also indicated that relationship exist between whatsapp usage and school adjustment among student with the following values; whatsapp usage and school adjustment r=0.779, p=.000. facebook and school adjustment r=0.662, p=.000. Zulkarnain and Febriyanti (2022) also stated that WhatsApp platform was found to be the best programme to use in online learning on the basis of the study. The research results also showed that the WhatsApp application is the easiest application to use in online learning. The advantages felt by pre-service teachers when learning using the WhatsApp application include; learning to be more flexible, increasing self-confidence, being able to hone skills in making technology-based learning media and being able to obtain information easily and from various sources which enhanced effective school adjustment. Meanwhile, the obstacles felt by pre-service teachers included a lack of concentration in learning, constrained by an unstable network, difficulties in conducting discussions with groups, and difficulty understanding the material as a whole. Golam Rabbani Sarker (2015) also revealed that WhatsApp has a profound negative impact on students' school adjustment and adversely affects their education, behaviour and routine lives. It messes up much of study time of

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026350

students and distracts them from completing their assignments. This app has been found to be highly addictive. The study concluded that time management is essential for online activities.

Conclusion

This study explored the relationship between personality traits and undergraduates' school adjustment in Calabar Education Zone, Nigeria. The findings revealed significant correlations between Facebook usage and WhatsApp usage, highlighting the profound impact of personality on academic behavior. Based on the results and findings of the study, the following conclusions were reached. WhatsApp usage and Facebook usage significantly predict undergraduates' school adjustment.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Encourage universities to create official Facebook groups for each department or program. This would serve as a platform for academic announcements, resources sharing, and networking among students and faculty.
2. Establish WhatsApp study groups for students to facilitate collaborative learning. Instructors can guide the groups and provide moderation to keep discussions focused and productive.

By implementing these recommendations, stakeholders can address academic procrastination tendency, promote academic success, and foster holistic well-being among undergraduate students in Calabar Education Zone, Nigeria.

References

Abbasi, A. M., Lashari, A. A, Kumar, H., Khan, S. & Rathore, K. (2021). Impact of facebook on the trends of university students. *Journal of Social Sciences and Media Studies*, *3*(2), 29-37.

Ahmad, S, A. (2023).Students attitude towards using WhatsApp for educational activities at federal university Dutsin-Ma, Katsina State, Nigeria. *FUDMA Journal of Sciences (FJS), 4*(2), 749 — 757.

Al-Mothana, M. G. (2023). University Students use of WhatsApp and their perceptions regarding its possible integration into their education. *Global Journal of Computer Science and Technology*, *17*(1), 1-11.

Berk, R. A. (2019). *Multimedia teaching with video clips: TV, movies andYoutube*. Lagos. Wesami Publishers.

Bhatt, A. & Arshad, M. (2016). Impact of WhatsApp on youth: A Sociological Study. IRA International Journal Management and Social Sciences 4, 376—386.

Boon, S., & Sinclair, C. (2019). A world I dont inhabit: disquiet and identity in Second Life and Facebook. *Educational Media International, 46*(2), 99-110.

Bouhnik, D. & Deshen, M. (2014). WhatsApp goes to school: Mobile instant messaging between teachers and students. *Journal of Information Technology in Educational Research, 13*, 217—231.

Boyd, D. M., & Ellison, N. B. (2007). Social network sites: Definition, history, and scholarship. Journal of Computer-Mediated Communication, 13(1), 210-230.

Briggs, P. (2021). *Canada social media 2021*. Insider Intelligence. https://www.emarketer.com/content/canada-social-media-2021

Calabuig, S., & Donaire, J. A. (2012). El debate y la síntesis de aportaciones colaborativas en la educación superior con el Twitter como protagonista. In Alba, N., García Pérez, F., & Santisteban, A. (Eds.), *Educar para la participación ciudadana en la enseñanza de las Ciencias Sociales*, 2; 527-535. Seville, Spain: AUPDCS.

Carlen, U. & Jobring, O. (2015). The rationale of online learning communities. *International Journal of Web Based Communities, 1,* 272—295.

Chen, L., & Chen, T.-L. (2012). Use of Twitter for formative evaluation: Reflections on trainer and trainees experiences. *British Journal of Educational Technology*, *43*(2), 49—52.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026350

Chia-chen, Y. & Brown, B. (2021).Factors involved in associations between Facebook use and college adjustment: Social competence, perceived usefulness, and use patterns. *Computers in Human Behaviour, 46*(5), 245—253

Enaohwo, A. K. & Awotua-Efebo, E. B. (2023). Students interest on the usage of WhatsApp as a digital learning tool in tertiary institutions in Port Harcourt Metropolis. *African Journal of Educational Research and Development (AJERD) 11*(1), 220-230.

Gemmill, E. L. & Peterson, M. (2016). Technology use among college students: Implications for student affairs professionals. *Journal of Student Affairs Research and Practice,* 43 (2), 482—502.

Gilroy, M. (2020). Higher education migrates to Youtube and social networks. *The Education Digest, 75*(7), 18-22.

Golam, R. S. (2015). Impact of WhatsApp messenger on the university level students: A sociological study. *International Journal of Natural and Social Sciences,* 2 (4), 118-125.

Gray, R., Vitak, J., Easton, E. W., & Ellison, N. B. (2013). Examining school adjustment to college in the age of social media: Factors influencing successful transitions and persistence. *Computers & Education, 67,* 193-207.

Lee, C. E., Chern, H. H. & Azmir, D. A. (2023). WhatsApp use in a higher education learning environment: perspective of students of a Malaysian private university on academic performance and team effectiveness. *Education Sciences,* 13, 232-244.

Meenakshi, K. T. & Lakshmi, A. K. (2023). Impact and uses of WhatsApp among college students. *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, 8 (11), 722-725.

Mohammed, I., Samson, J. & Sadiq, I. T. (2023). Social media usage and social adjustment among FCE Students Zaria, Kaduna State, Nigeria. *World Journal of Interactive Research*(WJIR), *3*(1), 1-10.

Perifanou, M., Tzafilkou, K. & Economides, A. A. (2021). The Role of Facebook, Instagram and Youtube frequency of use in university students digital skills components. *Education Science, 2*(1), 11-27.

Umar R., Puspitasari, E. & Hidayati, D. (2023). The impact of WhatsApp toward UAD undergraduate students behaviour in learning process. *International Journal on Education, Management and Innovation (IJEMI), 1*(1), 55-68.

Yeboah, D. & Nyagorme, P. (2022). Students acceptance of WhatsApp as teaching and learning tool in distance higher education in sub-Sharan Africa. *Cogent Education, 9,* 20-45.

Yunusa, D. U. &Bukar, A. (2022).Students usage of WhatsApp instant messenger as a supporting tool for learning in Kaduna State, Nigeria. *International Journal of Education and Development using Information and Communication Technology (IJEDICT),* 18(*3),* 147-158.

Zulkarnain, R. N. & Febriyanti, R. (2022). Online lectures using the WhatsApp application: advantages and obstacles. *Advances in Social Science, Education and Humanities Research, 619; 176-180.*

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026351

Effect of In-Class Flipped Classroom Model on Academic Performance in Practical Biology Concepts among Secondary School Students in Kebbi State, Nigeria

USMAN, Aisha Abdulrahman[1]
usmanabdulrahmanaisha@gmail.com
+2347067581220

SHAMSUDEEN, Bello[1]
shamsudeenmarina@gmail.com
08032890327

AHMAD, Hadiza Gusau[1]
hadizaahmadgusau@gmail.com
08062774854

[1]Department of Science Education, Sokoto State University, Sokoto State, Nigeria

Abstract
This study investigated the effect of In-Class flipped classroom model on academic performance in practical biology concepts among senior secondary school students in Kebbi State, Nigeria. A quasi-experimental group design involving pretest- posttest control group was adopted. A total of 383 students participated in the study. The instruments used for data collection was Biology Practical Academic Performance Test (BPAPT). Data were analyzed using t-test, ANOVA, and Scheffé post hoc test at 0.05 level of significance. Findings revealed that students taught practical Biology Concepts using In-Class flipped classroom model significantly outperformed those exposed to Conventional flipped classroom model (t = 20.554, p = 0.001). Although ANOVA indicated an overall significant gender difference (p = 0.001), the Scheffé post hoc analysis revealed that gender differences within each instructional method were not statistically significant, implying that the model is gender-inclusive. The study concludes that In-Class flipped classroom is a more effective and equitable instructional approach for enhancing students' performance in practical biology. It recommends that biology teachers, curriculum planners, and policymakers integrate the In-Class flipped model into secondary school science instruction to promote active learning and improve practical skills acquisition.

Keywords: Practical biology, Academic performance, in-class and Conventional flipped classroom

Introduction
Inverting the classroom means that events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa (Maureen, Glenn, Michael 2000). To invert means to turn inside out or upside down‖, which has the similar meaning with the word Flip. Flipping 'the classroom can improve the traditional lecture; it can provide a large range of mixture of educational methods in which students get prepared materials and then take part in structured In-Class activities. Bryan and Miller (2013) stated that the Flipped Classroom makes the students learn tasks before class to spot the difficulties. The tasks go through three similar procedures: first, before class all the students watch the teaching video designed by the teacher. Second, the students try to finish all the tasks given by the teacher. Third, all the students discuss with teacher or classmates through platform to share the answers and write down those unsolved and difficult questions. Thus, the students can work out the unsolved and difficult questions with classmates or teachers rather than get the basic information passively in class. Sams, Bergmann (2013) considered flipped classroom as a teaching method, which mainly proposes that what is traditionally done in the

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026351

classroom is now done at home, and that students do homework or do some classroom activities in the class. From the previous studies, different scholars offer different definitions on the Flipped Classroom such as Bryan and Miller (2013); Lage, Platt &Treglia (2000). However, there are some similarities in the previous definitions, which focus on the student-based approach and inverting the teaching procedure. After learning the previous definitions of the Flipped Classroom, Sams, Bergmann (2013) define Flipped Classroom as pedagogical method in which students learn new knowledge through short videos, podcasts, e-books as well as internet outside class and consolidate what they acquired through classroom activities with the help of classmates and teachers. There is no exact model that a flipped classroom has to fit. Even though there are ineffective models of a flipped classrooms that do not allow for the pedagogy to be used to the fullest potential, there are more than one effective model that has the components necessary to be successful. Flipped classroom is concerned with the practice where content is made available to the learners before the teaching and learning contacts, usually for pre-class study while the In-Class activities are facilitated by the teacher to foster the comprehension of the content (Brewer & Movahedazarhouligh, (2018); O'Flaherty & Phillips, 2015). There are three major models or types of flipped classroom instructions methods, namely: Traditional or Conventional Flip, In-Class Flip and Mastry Flip (Bergmann and Sams (2012). Traditional flip, Students are usually assigned video, image or task as homework. The purpose of this homework is to introduce or preview the information that the students will need for the next lesson. The students watch the videos and complete any corresponding work that goes with it. The next day in class, the teacher reviews any questions the students may have and introduces the learning activity for the day. Students complete during class, the work that would have been traditionally assigned as homework. In all flipped classroom models, the teacher is available to facilitate discussion, guide learning, and help students solve problems as they work through a concept. Students are responsible for completing the learning activities by a particular due date. They are also responsible for taking ownership of their learning by completing any and all assigned as home learning exercises. Flipped classroom model is effective because it gives students an opportunity to interact, engage, and learn from their peers. The Traditional flip is the most recognized and most commonly used model of flipping the classroom (Johnson et al., 2015).

The next is the In-Class flip which similar has characteristics like the Traditional flip, with the exception that students need to complete video-watching or learning activities at home. In the In-Class flip, all learning activities, including the introductory lecture or activity, is done within the classroom. The classroom is set up into stations where groups of student work independently, collaboratively, or a combination of the two, to complete the project-based, critical thinking activities. Gonzalez (2014) stressed the importance of having a few infinite stations where the activity is never really over but has many possibilities and variations that can be useful for students who complete an activity early. They can use these stations as reinforcement while waiting for the rest of their group to complete the original task. The difference between the In-Class flips and simple station work is the role of the teacher. The teacher is free to move between the stations to guide learning, help clear up any misconceptions, but never having to redeliver the lesson itself (Gonzalez, 2014). As identified by Bergmann and Sams (2012), the Mastery Flip has three main components: Students work either in small groups or individually at an appropriate pace. The teacher formatively assesses students and gauges student understanding. Students demonstrate mastery of objectives on summative assessments. For students who do not master a given objective, remediation is provided. As activities are completed, students demonstrate their knowledge in the summative assessments. If their performance on those assessments meets the criteria, they are free to move on to the next set

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026351

of learning objectives. If not, they complete additional learning activities until they have mastered the concept. Academic performance refers to the student's level of achievement, typically measured through Practical test assessment and main examinations which can be within School, Academic performance of students has always been a subject of interest to every educational institution. Whereas there is a consensus that schools should play a major role in this process, there seems to be disagreement about what exactly that role should be. While some believe that the primary focus of schools should be the academic preparation of students (Hirsch,2001). Others however believe that efforts of schools should be integrated with other social institutions such as family and community towards educating children (Huitt, 2007). In fact, heads of educational institution, teachers and parents are primarily responsible for students' academic performance (Darling-Hammond, 2010), and that schools should efficiently and effectively organize themselves towards this task (Engelmann & Carnine, 1991). Biology is the scientific study of life. It is a natural science with a broad scope but has several unifying themes that tie it together as a single, coherent field. Biology is a natural science discipline that studies living things. (*Hillis, et al 2020)* Biology practical teachings are important in order to understand biology concepts, Science education targets to enhance the understanding of the natural world by students and how it works, then the students have to experience and spot the relevant of science phenomena. Recent studies advocate for a change in teaching method so that student participate fully and understand different science concepts (Miller & Levine, 2010). Students should understand processes and structure; develop skills in manipulation, processing of science information and conducting scientific investigations (Akinwumi & Falemu 2020).

Statement of the Problem

Biology as a science subject requires trained techniques and the laboratory attendants employed. In few school's laboratory attendants are dropouts no basic knowledge of how to prepare specimen for biology Practical. In most cases, these laboratory attendants lack technical know how to operate, maintain, repair or service the few available equipment when they broke down. According to the Kebbi State Ministry of Education (2023/2024) student perform poor in biology practical leading to their failure in biology examiners. Similarly, WAEC Chief Examiners (2023/2024) reported that performance of candidate in practical biology fell below expectation. The report discussed the candidate Weakness under the following sub headings: Poor Spelling, Poor Observation, Poor mathematical Skills, and Poor deductive reasoning, Mis-interpretation of question, poor knowledge of biology, Lack of engagement, Lack of time and Teacher professionality. The examiner lamented that there were many Candidates who could not answer correctly a single question in section A. In most cases, they have wild guesses and quite unrelated answer that were sometimes Un-biological. Based on the poor academic (2023/2024) Stated that objectives of practical Biology are not being realized to a satisfactory extent. The WAEC Chief Examiner's (2023/2024) pointed out that the poor academic performance in biology practical are caused by Lack of Well quipped laboratory, Inadequate qualified biology teachers, limited time-table hours Poor Observation, Poor drawing and labelling and Poor comparison of Specimens, these begin state of affairs is disturbing. They also Observed that the biology laboratory was in-adequately as a result of the students were not adequately involved only Practical lessons. The students only Watched teachers 'demonstration exercise. And also, the majority of secondary schools in Kebbi State do not have laboratories exist, the learners therefore have to memorized practical work theoretically in order to pass the examination when they are writing practical biology Papers. Most of the learners sit for examination without being exposed to Practical Work. Despite this, available data indicates an underachievement rate in the subject. Studies have linked the achievement issue to varying factors and reasons, but one variable that has continually

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026351

been brought to light is issues related to strategies used to teach biology. According to the West African Senior School Certificate Examination (WASSCE) Chief Examiner 's report in kebbi state on student performance in practical biology: The performance of the candidates 2023 was worse than the previous year with a population of 1,068,564, raw mean score of 29 and standard deviation of 08.25 this year (2024) against that of WASSCE for school candidate, 2022 which had a population of 1,048,242, and a raw mean score of 36 and standard deviation of 11.66. It is against these problems that the current study aims to bridge this gap by investigating the effect of In-Class and Conventional Flipped classroom model on students' academic performance in practical biology in kebbi state, Nigeria.

Objectives of the Study

The main objective of this study is to examine the effect of In-Class Flipped classroom Model on Academic Performance in Practical Biology among secondary school Students in Kebbi State, Nigeria. The Specific Objectives are to:

1. Determine the difference between academic performance of Senior secondary school students taught practical biology using in-Class flipped model and those exposed to Conventional flipped classroom model in kebbi State, Nigeria
2. Assess the difference between Male and Female academic performance of senior secondary school students expose to In-Class Flipped and those expose to Conventional flipped classroom model in Practical Biology in Kebbi State. Nigeria.

Research Questions

Based on the above research objectives, the following research questions were raised.

1. What is the mean difference in academic performance scores of secondary school students taught practical biology concept using in-Class flipped model and those exposed to Conventional flipped classroom model in kebbi State, Nigeria?
2. What is the mean difference in academic performance scores between male and female secondary school students taught practical biology concept using in-Class flipped model and those exposed to Conventional flipped classroom model in kebbi State, Nigeria?

Research Hypotheses

The following null hypotheses were formulated;

Ho_1. There is no significant difference between the academic performance of secondary school students taught Practical Biology using In-Class Flipped classroom model and those Exposed to Conventional Flipped classroom model in Kebbi State Nigeria.

Ho_2. There is no significant difference between the academic performance of secondary school students taught Practical Biology using In-Class Flipped classroom model and those Exposed to Conventional Flipped classroom model in Kebbi State Nigeria.

Research Methodology

A quasi-experimental research design was used for this study, with a target population of 23,730 biology SS II students in all the 119 public secondary schools distributed among 6 educational zones in Kebbi State. About 383 SSII biology Students comprising of 218 Males and 165 Females Students were selected within four secondary schools in two educational zones (Birnin Kebbi and Argungu), using purposive and multi Stage Sampling techniques.

Table 1: Summary of the sample size of schools, groups and students according to gender

S/N	Name of Schools	Group	SS2 Males	SS2 Females	Total
1	G. D. S. S. Argungu	Experimental 1	58	42	100

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026351

2	S.S.S.	Argungu	Experimental	2	56	43	99
3	G.D.S.S.	B/Kebbi	Control	1	56	43	99
4	S.H.G.G.S	B/Kebbi	Control	2	48	37	85
	Total				**218**	**165**	**383**

Multi stage and purposive sampling were used to ensure a more representative sample for the populations. Also, intact Classes were used for each group i.e two experimental groups and two control groups. Biology Practical Academic Performance Test (BPAPT) was used as the instrument for data collection and was submitted to experts for validation. Some of their observations are; contents are adequate to answer the research Questions, Construct Validity was examined and found okay. A pilot test was conducted in Dankoji Government Day Secondary School (DGDSS), Argungu which is not part of sample, using test - retest method with two weeks interval. Data obtained after the test were analysed using Pearson Product Moment Correlation coefficient (PPMCC). The reliability of Co efficient arrived at was 0.77. The data collection was made in three phases that is Pre-treatment, Treatment and Post- Treatment stage. Data was collected using a Pre-Test for Biology Practical Academic Performance Test (BPAPT) for both experimental and the control groups two weeks before the commencement of treatment phase of the research. This research aimed to comparing two models of flipped Classroom strategy, namely: Traditional and in Class Flipped Models. In this research Traditional Flipped classroom model was involved giving each student all the information's including images and specimen to study at home. During the lesson, what students observed at home was used to facilitate learning using guided discussion learning approach While for In-Class model, no student was given any task to study at home. Instead, the students were divided into groups and assigned a space in the classroom to study the images and specimen in the classroom for sometimes. Later, observation was used by the teacher to facilitate learning through discussion and guided learning strategy. This was done to determine the entry consistency between the groups. As treatment, one set of experimental group was taught Digestive System and Germination using In-Class Flipped Classroom; while the Control group was taught Digestive System and Germination using Traditional Flipped classroom. At the end of the treatment, the groups in different schools were administered Biology Practical Academic Performance Test (BPAPT) again as Post Test and the Score of Students was used as data. The data collected were analysed using independent sample t-test for Biology Practical Academic Performance Test (BPAPT), while ANOVA was used for analyse the difference between genders and Scheffe's Post Hoc, to comprised test for difference between Performance of Male and Female Students

Presentation of Results

Based on the results obtained the analysis and interpretation were done with the use of tables to provide a clear picture of the findings as follows:

Research Question One: What is the mean difference in academic performance scores of secondary school students taught practical biology concept using in-Class flipped model and those exposed to Conventional flipped classroom model in kebbi State, Nigeria?

Table 2: Descriptive Statistics Result of the Biology Practical Academic Performance Test (BPAPT) between Experimental and Control Group

Group	N	Mean	Standard Deviation	Mean Difference
Experimental	199	26.3618	5.1561	11.6716
Control	184	14.6902	5.9512	
Total	**383**			

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026351

Table 2 is a summary of Mean and standard deviation calculated to assess the difference in the Biology practical academic performance test (BPAPT) in practical biology between experimental (in-class flipped classroom) and control (conventional flipped classroom) groups. The result shows the experimental group, which was exposed to the in-class flipped classroom model, had a mean score of 26.36 with a standard deviation of 5.16, indicating relatively high performance with moderate variability among students' scores. In contrast, the control group, which was taught using the conventional flipped classroom model, recorded a mean score of 14.69 with a standard deviation of 5.95, reflecting lower academic performance and slightly greater dispersion of scores compared to the experimental group. The mean difference between the experimental and control groups was 11.67, showing that students exposed to the in-class flipped classroom model outperformed those in the conventional flipped classroom model by a wide margin. Furthermore, the difference in standard deviation between the two groups was 0.79 (SD = 5.95 -5.16), indicating that scores in the control group were more widely spread than those of the experimental group. This suggests that, in addition to achieving higher academic performance, students in the experimental group demonstrated more consistent learning outcomes. Overall, the results indicate that the in-class flipped classroom model was more effective in enhancing students' academic performance in practical biology than the conventional flipped classroom model.

Research Question two: What is the mean difference in academic performance scores between male and female secondary school students taught practical biology concept using in-Class flipped model and those exposed to Conventional flipped classroom model in kebbi State, Nigeria?

Table 3: Descriptive Statistics Result of Male and Female Students' Posttest Academic performance in Practical Biology between Experimental and Control Group.

Group	Gender	N	Mean	Std. Dev.	Mean Difference
Experimental	**Male**	114	26.7105	5.1245	0.8164
	Female	85	25.8941	5.1916	
Control	**Male**	105	14.0476	6.2070	1.4967
	Female	79	15.5443	5.5164	
Total		**383**			

Table 3 presents the descriptive statistics of male and female students' post-test academic performance in practical biology across the experimental and control groups. In the experimental group, male students recorded a mean score of 26.71 with a standard deviation of 5.12, while female students had a mean score of 25.89 and a standard deviation of 5.19. The mean difference between male and female students in the experimental group was 0.82, indicating a very small difference in performance in favour of the male students. The difference in standard deviation between the two subgroups was 0.07, suggesting nearly identical variability in their performance. In the control group, male students obtained a mean score of 14.05 with a standard deviation of 6.21, whereas female students recorded a mean score of 15.54 and a standard deviation of 5.52. The mean difference between male and female students in the control group was 1.50, slightly in favour of the female students. The difference in standard deviation was 0.69, indicating greater variability in performance among male students in the control group. Overall, the results show that male and female students in the experimental group performed at nearly the same level, with minimal differences in both mean scores and variability. In contrast, although slight gender differences were observed in the control group, these differences were small. This suggests that the in-class flipped classroom model promoted comparable academic performance among male and female students in practical biology.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026351

Hypothesis One (H_{01}):

There is no significant difference between the academic performance of secondary school students taught Practical Biology using In-Class Flipped classroom model and those Exposed to Conventional Flipped classroom model in Kebbi State Nigeria.

Table 4: Independent Samples t-test Analysis of Academic Performance in Practical Biology between Experimental and Control Group

Group	N	Mean	SD	*df*	t-Cal	p-Value	Decision
Experimental	199	26.3618	5.1561				H_{01}
				381	20.554	0.001	Rejected
Control	184	14.6902	5.9512				

Table 4 presents a summary of independent t-test comparison to determine the significance of the mean difference between academic performance of experimental group and control group. The mean and the standard deviation of the experimental group is 26.36 and SD is 5.16 respectively, while in the control group the Mean is 14.69 and SD is 5.95 respectively. Thus, since the p-Value of 0.001 was less than < 0.05 level of significance (p=0.001<0.05), the null hypothesis one (H01) was rejected which means the Mean difference between the two group is statistically significant. Therefore, the students exposed to the In-Class flipped classroom model performed significantly higher than those exposed to the Conventional flipped classroom model in practical biology in Kebbi state, Nigeria. Hence, In-Class flipped classroom model was a more effective in enhancing academic performance of students in practical biology in Kebbi state, Nigeria than the Conventional flipped classroom model.

Hypothesis Two (H_{02}):

There is no significant difference between the academic performance of secondary school students taught Practical Biology using In-Class Flipped classroom model and those Exposed to Conventional Flipped classroom model in Kebbi State Nigeria.

Table 5: ANOVA Analysis of Posttest Academic Performance in Biology Practical between Male and Female Students in the Experimental and Control Group in Kebbi State

Variation	Sum of Squares	*df*	Mean Square	F-Cal	p-Value	Decision
Between	13157.078	3	4385.693	143.145	0.001	H_{04}
Within	11611.851	379	30.638			Rejected
Total	**24768.930**	**382**				

Table 5: presents a summary of Analysis of Variance (ANOVA) conducted to determine whether a significant difference exists in the posttest academic performance in biology practical among male and female Secondary School Students in the experimental and control groups in Kebbi State. The result of the ANOVA showed a calculated F-value of 143.145 with 3 and 379 degrees of freedom and a p-value of 0.001 at the 0.05 level of significance. Since the p-value of 0.001 was less than the 0.05 level of significance (p = 0.001 < 0.05), the null hypothesis two (Ho_2) was rejected. This indicates that there was a statistically significant difference in posttest academic performance in biology practical among male and female students in the experimental and control groups. Therefore, academic performance in biology practical differed significantly across gender and treatment groups in Kebbi State, Nigeria. The specific locations of these differences are further explained using the Scheffé's post hoc multiple comparison test presented in Table 6.

Table 6: Scheffe's Post Hoc Comparison Test for Difference between Performance of Male and Female Students in the Experimental and Control Group in Kebbi state

Treatment Group	Gender	N	Subset for alpha = 0.05	
			1	2
	Male	105	14.0476	

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026351

Control				
	Female	79	15.5443	
	Female	85		25.8941
Experimental				
	Male	114		26.7105
Sig.			**0.332**	**0.797**

Table 5: is a summary of the Analysis of Variance (ANOVA) computed to determine the significance of the mean differences in the academic performance in biology practical of male and female Senior Secondary School students exposed to In-Class flipped classroom model and those exposed to Conventional flipped classroom model in Kebbi state, Nigeria. The results of the analysis revealed that there was statistically significant difference among performance of male and female students in the experimental and control group at calculated F ratio of 143.145, with a p-Value of 0.001 at 0.05 level of significance $F(3, 379) = 143.145$, $p = 0.001$ & $\alpha = 0.05$ level of significance. Therefore, since the p-Value of 0.001 is less than 0.05 level of significance ($p < 0.05$), the null hypothesis two (H_{02}) was also rejected. This implies that a statistically significant difference exists among the means of males and females in the groups.

Table 6 presents results of Scheffe's Post Hoc multiple comparison test to show where significant difference exists in the mean performance of students in biology practical between male and female in the experimental and control group. The result of the multiple comparison revealed that the academic performance of experimental Male (Mean = 26.71) and Female (Mean = 25.89) students exposed to In-Class flipped classroom model were significantly different from their control Male (Mean = 14.05) and female (Mean = 15.54) students exposed to the Conventional flipped classroom model. However, no significant mean difference exist between male and female students' performance in Biology practical in both experimental (p=0.797) and control (p=0.332) group.

Discussion of Findings

This study assessed the effects of In-Class flipped classroom model on academic performance in biology practical among senior secondary school Students in Kebbi state, Nigeria. The first finding of the study revealed that students exposed to the In-Class flipped classroom model performed significantly better than those exposed to the Conventional flipped classroom model in biology practical in Kebbi state. This finding confirmed the finding of a similar research study conducted by Malto, Dalida, and Lagunzda (2018), who conducted a similar study in Philippines, to evaluate the impact of the flipped classroom approach on students 'academic achievement and attitude toward biology. They found that flipped classroom group showed significantly higher academic performance in biology than the control group exposed to Conventional method suggesting that exposure to flipped classroom instruction enhanced students 'understanding of biological concepts and fostered better performance in the subject. Similarly, the finding of this study corroborated the findings of Nja, Orim, Neji, 2022), who conducted a similar study in Calabar, Nigeria, to examine how the flipped classroom approach influences students 'attitudes and academic achievement. Nja, et al (2022), found that flipped classroom strategy significantly improved second-year chemistry students 'academic performance, particularly in the redox reaction test. Overall, the results indicated that integrating flipped classroom practices positively impacted both students 'engagement with chemistry and their academic outcomes. Also, the finding of this study supported the findings of Eze (2023), who examined the impact of flipped learning on the interest and achievement of Nigeria Certificate in Education (NCE) mathematics students in Trigonometry in Kano State. They found that significant differences exists in achievement scores between the experimental and control groups in which

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026351

students taught Trigonometry using the flipped classroom approach achieved higher mean scores than those taught with the traditional lecture method. The study recommended that mathematics lecturers in Nigerian colleges of education should adopt flipped learning as a teaching strategy, and that this method be integrated into mathematics instruction at all levels of the Nigerian education system to enhance both student interest and academic performance. In addition, the finding was in line with the findings of Ogunleye, Onifade, Ogundeji, and Sonde (2024), who also studied the effect of Flipped Classroom Strategy on the Performance and Cognitive Style of Senior Secondary School Biology Students in Ogun State, Nigeria. The results of their study revealed that students exposed to flipped method performed significantly better than those exposed to Conventional lecture method suggesting the efficacy of the flipped classroom model on enhanced academic performance in biology. Similarly, the finding of the study confirmed the results of a similar study by Susuoroka, Afful, Kwadwo, and Sawyer (2024), who explored how the flipped classroom teaching strategy influences students'motivation in numeracy and their academic performance in basic schools within Tumu Municipal, Ghana. The findings revealed that the flipped classroom model was more effective than traditional teaching methods in enhancing both numeracy achievement and motivation among Ghanaian basic school pupils. They recommended that basic schools should adopt the flipped classroom approach to foster higher motivation and improved learning outcomes.

Conclusion

Based on the findings of this study, it can be concluded that the In-Class flipped classroom model is a more effective instructional approach than the Conventional flipped classroom model in teaching practical biology at the secondary school level. Students exposed to the In-Class flipped classroom model demonstrated significantly higher academic performance. These outcomes suggest that the In-Class flipped approach promotes active participation, meaningful interaction, and deeper understanding of biological concepts during practical activities.

Recommendations

Based strictly on the findings of this study, it is recommended that:

1. Biology teachers in secondary schools should explore the use of In-Class flipped classroom model for teaching practical biology, as the model was found to significantly improve students 'academic performance.
2. Since students exposed to the In-Class flipped model demonstrated better learning outcomes, its use should be encouraged during biology practical lessons to promote active participation and deeper understanding of concepts.

References

Akinwumi, I. O., & Falemu, F. A. (2020). Effects of biology practicals on academic performance of secondary school students in biology in Ikere Local Government Area of Ekiti State, Nigeria. *International Journal of Innovative Studies, 4*(10), 1–11.

Brewer, R., & Movahedazarhouligh, S. (2018). Successful stories and conflicts: A literature review on the effectiveness of flipped learning in higher education. *Journal of Computer Assisted Learning, 34*(4), 409–416. https://doi.org/10.1111/jcal.12250

Bryan, G., & Miller, K. (2013). Evidence on flipped classroom is still coming in. *Educational Leadership, 70*(6), 78–80.

Darling-Hammond, L. (2010). *The flat world and education: How America's commitment to equity will determine our future.* Teachers College Press.

Engelmann, S., & Carnine, D. (1991). *Theory and instruction: Principles and application* (Rev. ed.). ADI Press.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026351

Eze, L. I. (2023). Effect of flipped learning on Nigeria Certificate in Education (NCE) mathematics students' interest and achievement in trigonometry in Kano State, Nigeria. *British Journal of Education, 11*(8), 76–91.

Gonzalez, J. (2014, March 24). Modifying the flipped classroom: The "in-class" version. Edutopia. http://www.edutopia.org/blog/flipped-classroom-in-class-version-jennifer-gonzalez

Hillis, D. M., Heller, H. C., Hacker, S. D., Laskowski, M. J., & Sadava, D. E. (2020). *The science of biology* (12th ed.). W. H. Freeman.

Hirsch, E. D. (2001). *The schools we need and why we don't have them*. Doubleday.

Huitt, W. (2006, April 26). Becoming a brilliant star: A framework for discussing formative holistic education. Paper presented at the International Networking for Educational Transformation (iNet) Conference, Augusta, GA.

Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2015). *NMC horizon report: 2015 higher education edition*. The New Media Consortium. http://cdn.nmc.org/media/2015-nmc-horizon-report-HE-EN.pdf

Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the classroom: A gateway to creating an inclusive learning environment. *Journal of Economic Education, 31*(1), 30–43.

Malto, G. A. O., Dalida, C. S., & Lagunzad, C. G. B. (2018). Flipped classroom approach in teaching biology: Assessing students' academic achievement and attitude towards biology. *KnE Social Sciences, 3*(6), 540–554. https://doi.org/10.18502/kss.v3i6.2403

Miller, K. R., & Levine, S. (2010). Making real the promise of active learning. Paper presented at the National Conference of the American Association for Higher Education, Washington, DC.

Nja, C. O., Orim, R. E., Neji, H. M., Ukwetang, J. O., Uwe, U. E., & Ideba, M. A. (2022). Students' attitude and academic achievement in a flipped classroom. *Heliyon, 8*(1), e08792. https://doi.org/10.1016/j.heliyon.2022.e08792

O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. *Internet and Higher Education, 25*, 85–95.

Ogunleye, A. T., Onifade, O. J., Ogundeji, A. F., & Sonde, P. O. (2024). Effect of flipped classroom strategy on the performance and cognitive style of senior secondary school biology students in Ogun State, Nigeria. *Ilorin Journal of Education, 44*(1), 318–329.

Sams, A., & Bergmann, J. (2013). Flip your students' learning. *Educational Leadership, 70*(7), 16–20.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026352

Assessment of Teachers Preparedness and Challenges on Integration of Artificial-Intelligence Tools for Basic-Science Teaching among Universal-Basic-Education Schools in Kaduna State, Nigeria

OMAGWU, Ameh[1]
NUHU, I. Lawal[1]
BABALOLA, Victor T. [1]
OBEDA, Godwin[1]
Email: omagwu.ameh83@gmail.com;
GSM:07062663432

[1]Department of Science Education, Federal University, Gusau, Zamfara State, Nigeria

Abstract

This study investigates the preparedness of Basic Science teachers in Universal Basic Education (UBE) schools in Kaduna State to utilize Artificial Intelligence (AI) tools in teaching. A Descriptive research design was employed, gathering data through structured AI Integration in Basic Science Teaching Questionnaire" (AIIBST-Q) administered to 400 Basic Science teachers across UBE Schools in Kaduna State was validated through expert review and pilot testing, and its high reliability (Cronbach's Alpha = 0.87) was established, making it a robust tool for collecting the data presented in the study. The study utilized descriptive statistics and hypothesis testing to analyze the collected data Results reveal moderate technical proficiency (M = 3.2) but low pedagogical integration (M = 2.8), consistent with global patterns yet lower than in technologically advanced regions. Guided by the Diffusion of Innovation (DOI) theory, findings show AI adoption limited to early adopters mainly in private schools while a significant urban–rural gap (t = 4.12, p < .001) reflects deep infrastructure inequities. Major barriers include electricity shortages (78%), poor internet access (60%), lack of institutional support (90%), and inadequate training (65%), all of which hinder implementation of the Technological Pedagogical Content Knowledge (TPACK) framework. Additionally, psychological resistance (41%) suggests heightened techno-skepticism compared to other regions, shaped by local cultural contexts. The study concludes that AI integration in Kaduna's UBE schools is a systemic challenge, requiring multi-level action. Recommendations include creating a national AI education framework, investing in solar-powered solutions, subsidizing internet, embedding AI training in teacher professional development, and establishing supportive institutional policies. By addressing infrastructural, institutional, and attitudinal constraints, Kaduna State can leverage the moderate baseline preparedness of teachers to achieve sustainable AI adoption in education. This research offers practical roadmap for enhancing AI integration in low-resource settings.

Key Words: Universal Basic Education Schools, Artificial Intelligence, Basic Science

Introduction

The rapid advancement of Artificial Intelligence (AI) has ushered in transformative changes across various sectors, with education being one of the most significantly impacted. AI technologies, such as intelligent tutoring systems (ITS), chatbots, and adaptive learning platforms, are increasingly being leveraged to enhance teaching and learning processes (Luckin et al., 2016; Chen et al., 2020 & Babalola, et al., 2024). In science education, AI tools hold immense potential to personalize instruction, improve student engagement, and facilitate deeper conceptual understanding (Zawacki-Richter et al., 2019). For instance, AI-driven simulations and virtual labs have been shown to enhance students' problem-solving skills and scientific inquiry abilities (Bonnet et al., 2022). Despite these advancements, the successful integration of AI in classrooms largely depends on teachers' preparedness, which encompasses their technical proficiency, pedagogical adaptability, and confidence in using these tools (Hwang et al., 2020). Research indicates that teachers with higher

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026352

digital literacy are more likely to adopt AI effectively, whereas those lacking adequate training or institutional support face significant barriers (Kumar et al., 2021; Pedro et al., 2019). In developing contexts like Nigeria, challenges such as inadequate infrastructure, limited internet access, and sporadic electricity supply further complicate AI adoption in education including basic education (Oyelere et al., 2020). Prior to the emergence of AI innovation in Nigeria, the "do-it-yourself" Barrio School approach of the Petro T. Orata in Philippines has been suggested to address Nigerian's gross infrastructural deficit in her basic education schools (Babalola, 2015).

Basic Education is the cornerstone in the foundation of Nigerian education in which all other levels are building on. Basic education covers all classes in Nigerian schools below the senior secondary schools and the upper basic education is popularly known as the Junior Secondary School (Babalola, 2016). Nevertheless, all efforts must be geared towards avoiding wastages in basic education such as high drop-out rate and fail-out rate among the basic school students (Aliyu & Babalola 2016). An effort to prevent these wastages in basic education brought AI into the picture. In Kaduna State of Nigeria, the readiness of Basic Science teachers at the Upper Basic level to integrate AI tools into their instructional practices remains under-explored. While global studies highlight the benefits of AI in education, there is a paucity of empirical research focusing on the Nigerian context, particularly in science education at the foundational level (Atadoga et al., 2024 & Omagwu, et. at. 2025). Existing literature suggests that teachers in sub-Saharan Africa often struggle with technology integration due to insufficient professional development and a lack of policy frameworks supporting digital education (UNESCO, 2021). This study seeks to address this gap by assessing teachers' preparedness, identifying systemic challenges, and proposing actionable strategies to facilitate AI adoption in Basic Science education. The findings of this study will contribute to the broader discourse on AI in education by providing context-specific insights from Kaduna State. It will also inform policymakers, curriculum developers, and teacher training institutions on how to better support educators in harnessing AI's potential to improve science instruction. By bridging the gap between technological innovation and classroom practice, this research aims to foster a more inclusive and effective educational ecosystem in Nigeria.

Statement of the Problem

The integration of Artificial Intelligence (AI) in education presents both opportunities and challenges, particularly in developing regions like Nigeria. While AI tools have shown promise in enhancing science education globally, their effective implementation depends heavily on teachers' digital literacy, access to infrastructure, and institutional support. While AI technologies are rapidly transforming educational systems globally, the readiness of teachers to adopt and effectively use these tools remains a critical bottleneck, especially in developing contexts. In Kaduna State, the degree to which Basic Science teachers at the Upper Basic level are prepared to integrate AI tools is unclear. Their preparedness is influenced by factors such as digital competence, infrastructural support, and access to continuous training. The absence of empirical data on these dimensions poses a significant challenge to policy formulation, teacher training design, and curriculum development. This study seeks to bridge this gap by providing evidence-based insights into the current status of AI tool integration in Basic Science teaching in Kaduna State.

Research Objectives

1. Assess teachers' preparedness in using AI tools for Basic Science instruction.
2. Identify challenges in AI tool integration.
3. Examine institutional support and professional development opportunities.
4. Explore strategies to enhance teachers' readiness and address challenges.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026352

Research Questions

1. What is the level of teachers' preparedness in utilizing AI tools for Basic Science instruction?
2. What challenges hinder AI integration in Basic Science teaching?
3. What institutional support and professional development opportunities are available?
4. What strategies can improve teachers' readiness for AI adoption?

Artificial Intelligence in Education (AIED)

AIED refers to the application of machine learning, natural language processing, and data analytics to enhance teaching and learning processes (Luckin et al., 2022). In science education, AI tools such as adaptive learning platforms (e.g., Squirrel AI), virtual labs (e.g., Labster), and intelligent tutoring systems (e.g., Carnegie Learning) personalize instruction by analyzing student performance data and adjusting content delivery in real time (Holmes et al., 2023). Recent studies highlight AI's role in fostering inquiry-based learning for example, AI-driven simulations allow students to conduct virtual experiments, improving their conceptual grasp of scientific principles (Wang et al., 2023). However, the effectiveness of AIEd depends on contextual factors such as curriculum alignment and infrastructural readiness (Chiu et al., 2023). In Nigeria, AI adoption remains nascent due to limited access to technology and electricity shortages (Oyelere et al., 2023), underscoring the need for localized frameworks.

Teacher Preparedness

Teacher preparedness encompasses digital literacy, pedagogical adaptability, and confidence in using AI tools (Hwang & Tu, 2023). The Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) remains relevant, emphasizing that effective AI integration requires teachers to balance subject knowledge (Basic Science), teaching methods, and AI tool proficiency. A 2023 survey of Nigerian science teachers found that only 32% had received formal training on AI tools (Adewumi et al., 2023). Teachers in low-resource settings often resist AI adoption due to fear of job displacement or technical complexity (Selwyn, 2023).

Institutional Support Systems

Institutional support, including policy frameworks, infrastructure, and professional development, is essential for sustainable AI integration (Pedro et al., 2022). Successful models from other regions include:

1. Kenya's "AI for Teachers" program (UNESCO, 2023), which provided hands-on workshops and offline AI tools for rural educators.
2. India's National Digital Education Architecture (NDEAR, 2023), which mandated AI training for STEM teachers.

In Nigeria, the absence of a national AI education policy exacerbates disparities (Ogunleye, 2023). Schools with strong leadership support, however, report higher teacher engagement with AI (Ameh & Onojah, 2024).

Theoretical Framework

This study is based on two primary theories that explain how Artificial Intelligence (AI) is integrated into Basic Science education: the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) and the Diffusion of Innovation (DOI) theory (Rogers, 2003). Technological Pedagogical Content Knowledge (TPACK): The TPACK model stresses the importance of the connection between technology, pedagogy, and content knowledge, which is vital for successful AI integration (Mishra & Koehler, 2006). The framework highlights the dynamic relationship among teachers' expertise in science content (CK), teaching strategies (PK), and technological abilities (TK), showing that effective AI use depends on maintaining a balance among these areas. For example, a

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026352

teacher using AI-powered virtual labs must grasp the science concepts (CK), apply suitable teaching methods (PK), and manage the technology involved (TK). Recent research in Nigeria indicates that teachers with stronger TPACK skills are more likely to successfully incorporate AI tools (Ameh & Onojah, 2024). Diffusion of Innovation (DOI) Theory explains how new technologies like AI are adopted in education, highlighting the roles of innovators, early adopters, and laggards (Rogers, 2003). In addition to TPACK, DOI describes how AI tools spread through educational systems, focusing on factors such as perceived benefits (relative advantage), compatibility with existing practices, and the availability of training (complexity). For instance, schools with strong institutional support and teacher training are more likely to adopt AI, while those without the necessary infrastructure or policies tend to lag. Evidence from contexts like Kenya's AI training programs (UNESCO, 2023) emphasizes the need to address systemic barriers. By integrating TPACK and DOI, this study offers a holistic perspective to assess teachers' individual preparedness alongside the institutional and systemic factors facilitating AI adoption. This combined method guarantees that the recommendations for AI implementation in Kaduna State are both pedagogically effective and feasible for wider application.

Empirical Review

AI Integration in Science Education

Recent research shows that AI tools like virtual labs and simulations enhance students' understanding of concepts and boost engagement in science (Zawacki-Richter et al., 2019). For example, AI-based platforms such as Labster have yielded positive results in STEM education (Bonnet et al., 2022). Chiu et al. (2023) investigated how AI virtual labs affect student performance through a quasi-experimental study involving 1,200 Upper Basic students in Nigeria and Kenya. Their results indicated a 22% increase in test scores for students utilizing AI tools, especially when teachers offered guided support. Nonetheless, the study's short-term scope and absence of socioeconomic analysis restrict its relevance across varied classroom environments. Adewumi et al. (2023) examined teacher resistance to AI implementation via a mixed-methods study involving 350 Basic Science teachers in Nigeria. The findings revealed that 52% of teachers opposed AI primarily due to concerns about job security and technical difficulties, although training efforts lowered resistance by 28%. However, the study's focus on urban areas, particularly Lagos, limits its applicability to rural regions where infrastructure and training are less developed. UNESCO's (2023) survey of 200 Kenyan schools found that institutional support significantly influences AI adoption, as schools with clear policies tend to implement tools three times more quickly. Nonetheless, the study equated having policies with their effective enactment, neglecting cultural and logistical challenges that may prevent practical use. These studies highlight AI's potential in science education while also revealing gaps in long-term impact evaluation, equity issues, and policy alignment. Future research should focus on longitudinal studies, include rural and marginalized groups, and explore how institutional support influences classroom implementation. Policymakers need to improve infrastructure and provide teacher training to promote fair AI integration in diverse educational settings.

Challenges in AI Adoption

Recent studies identify ongoing obstacles hindering effective AI use in science classrooms, especially where resources are limited. 2023 multi-country research by Oyelere et al. found that infrastructure issues are the main barrier, with 78% of surveyed Nigerian schools lacking dependable electricity and internet needed for AI technology. This corresponds with UNESCO's 2023 assessment across Africa, which showed that only 32% of rural science teachers could regularly access digital learning platforms. The infrastructure deficiency contributes to a significant digital divide, mainly impacting

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026352

public and rural schools. Teacher-related challenges remain a significant obstacle. A 2024 mixed-methods study by Ameh and Onojah involving 500 Basic Science teachers in Northern Nigeria found that 67% of educators lacked confidence in using AI technologies, and 41% worried about AI replacing teaching jobs. This reluctance was especially common among older teachers and those without prior tech training. Although professional development programs showed some potential to change these attitudes, the study noted that most training efforts focused only on basic technical skills and did not effectively address how to integrate AI pedagogically. These studies collectively identify three key insights: First, infrastructure limitations create fundamental barriers to access. Second, teacher readiness involves both technical skills and psychological acceptance. Third, systemic issues like curriculum alignment and policy support greatly impact implementation success. However, current research often examines these challenges separately, with few studies exploring their combined effects. Future research should use holistic approaches that consider the interaction of technological, human, and systemic factors, especially in underrepresented regions. Common barriers include inadequate training, resistance to change, and lack of infrastructure (Selwyn, 2019). In Nigeria, electricity shortages and limited internet access further exacerbate these challenges (Oyelere et al., 2020).

Institutional Support

Recent research highlights the vital role of institutional support in ensuring successful AI integration in science classrooms. A 2023 international study by Pedro et al. surveyed 150 secondary schools in Sub-Saharan Africa and found that schools with comprehensive AI frameworks covering infrastructure, training, and policy alignment were 3.2 times more likely to succeed in implementation than those with limited or no support systems. The study's mixed-methods approach identified three key elements of effective institutional support: technological infrastructure (present in only 28% of Nigerian schools), ongoing professional development (offered by 19%), and curricular integration guidelines (available in 12%). The UNESCO (2023) report on AI readiness in African educational systems highlights notable inequalities in support structures. It found that 68% of private urban schools have dedicated AI budgets, compared to only 11% of rural public schools. The study emphasizes the influence of leadership, noting that schools where principals receive AI training are 4.5 times more likely to develop teacher support networks. Nonetheless, a significant gap remains, with 89% of current support efforts focused only on initial setup, overlooking ongoing maintenance and expansion. A longitudinal study by Chiu and Adewumi (2024), which tracked 45 Nigerian science classrooms over two years, provided nuanced insights into effective support structures. Their findings demonstrated that institutions combining formal training with informal peer-learning networks achieved 40% higher AI tool utilization rates. The research identified four levels of institutional support effectiveness: Basic (infrastructure only) - 12% adoption rate; Intermediate (infrastructure + training) - 34% adoption; Advanced (the above + curriculum integration) - 61% adoption; Comprehensive (all above + community partnerships) - 82% adoption

Emerging research by the African Educational Research Consortium (2024) uncovers innovative institutional support models. Their case study of a Lagos education district demonstrated how a "tripartite support system" involving government (policy), universities (expertise), and tech firms (resources) raised AI adoption from 8% to 63% within 18 months. A key factor was the creation of school-based "AI hubs" that serve as both resource centers and communities of practice. Although these studies offer valuable insights, several limitations remain. Most research focuses on urban settings (72% of studies in a 2024 meta-analysis), leaving the dynamics of rural institutions less explored. Furthermore, there's insufficient analysis of how support systems for institutions adapt to

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026352

changing AI technologies. Future research should utilize design-based implementation methods to evaluate support frameworks across various contexts and assess the cost-effectiveness of different models. Schools that provide strong professional development and access to AI resources tend to have higher teacher readiness (Pedro et al., 2019). For instance, the "AI for Teachers" program in Kenya boosted educators' confidence in using AI tools (UNESCO, 2021).

Research Gap

Although many global studies explore AI in education, few concentrate on Nigeria, especially at the Basic Science level in Upper Basic education. This research fills that gap by examining the specific challenges and opportunities in Kaduna State.

Research Methodology

This study uses a descriptive survey research design that combines both quantitative and qualitative methods to thoroughly examine teachers' preparedness, challenges, and institutional support concerning AI integration in Basic Science education at the Upper Basic level in UBE Schools, Kaduna State, Nigeria.

Population and Sampling

The target population includes all Basic Science teachers in UBE Schools at Upper Basic levels across the state, with a representative sample of 400 teachers chosen through stratified random sampling to ensure balanced representation across school types, geographic locations (urban/rural), and teacher demographics.

Instruments

Data collection employs two primary tools: a structured questionnaire with Likert-scale and open-ended questions to assess AI readiness, challenges, and institutional support, and semi-structured interviews with 30 purposively selected teachers to gather detailed, qualitative insights.

Validity and Reliability

The questionnaire undergoes thorough validity assessments through expert review and pilot testing, while reliability is maintained with Cronbach's Alpha scores of 0.70 or higher.

Presentation of Results

This chapter presents the analysis of data collected from 400 Basic Science teachers in Kaduna State, Nigeria, addressing the study's research questions. The chapter is organized into quantitative analysis (descriptive and inferential statistics) and qualitative analysis (thematic analysis of interviews). Results are discussed with reference to existing literature, and key findings are summarized to provide actionable insights.

Quantitative Data Analysis

Descriptive Statistics

Table 1: Demographic Characteristics of Respondents (N=400)

Location	Urban	240	60%
	Rural	160	40%
Teaching Experience	1–5 years	160	40%
	6–10 years	140	35%
	11+ years	100	25%

Survey, 2025

The demographic data reveals significant patterns in the sample population of Basic Science teachers in Kaduna State. Geographical distribution indicates an urban concentration, with 60% (n=240) of teachers located in urban areas versus 40% (n=160) in rural settings. This urban-rural divide may influence technology adoption patterns, as urban educators typically have better access to infrastructure and training opportunities. Teaching experience presents a relatively balanced

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026352

distribution across career stages: early-career teachers (1-5 years) comprise 40% (n=160) of the sample, mid-career (6-10 years) account for 35% (n=140), while veteran teachers (11+ years) represent 25% (n=100). This distribution suggests that while newer teachers dominate the workforce, there is substantial representation from more experienced educators who may bring different perspectives on technology integration.

Teachers' Preparedness in AI Utilization

Table 2: AI Preparedness Levels (5-Point Likert Scale, N=400)

Aspect	Mean Score (SD)	Interpretation
Technical Proficiency	3.2 (0.9)	Moderate
Pedagogical Integration	2.8 (1.1)	Low-Moderate
Confidence in AI Use	3.0 (0.8)	Moderate

The data reveals a moderate overall preparedness among Basic Science teachers in utilizing AI tools, with notable variations across different competency areas. Teachers demonstrated moderate technical proficiency (Mean = 3.2, SD = 0.9), suggesting that while many possess foundational skills to operate AI tools, there remains significant room for improvement in technical mastery. The slightly higher mean score in this domain compared to others may reflect growing exposure to digital technologies in teacher training programs. However, the standard deviation indicates variability in skill levels across the sample. However, pedagogical integration emerged as the weakest area (Mean = 2.8, SD = 1.1), falling into the low-moderate range. This suggests teachers struggle most with effectively incorporating AI tools into lesson planning, instructional delivery, and assessment strategies. The larger standard deviation here highlights substantial disparities. While some teachers may be experimenting with AI-enhanced teaching methods, others likely lack the pedagogical knowledge to move beyond basic technical use. Teachers reported moderate confidence in using AI (Mean = 3.0, SD = 0.8), indicating neither strong assurance nor complete discomfort with the technology. The narrower standard deviation for confidence compared to pedagogical integration suggests more consistent self-perceptions across the sample regarding their AI capabilities, though still below optimal levels for widespread implementation.

Challenges Hindering AI Integration

Table 3: Major Challenges Reported (Multiple Responses Allowed, N=400)

Challenge	Frequency (n)	Percentage (%)
Lack of Electricity	312	78%
Inadequate Training	260	65%
Poor Internet Access	240	60%
Resistance to Change	164	41%
Lack of AI Tools	148	37%

The data reveal a hierarchy of significant barriers preventing effective AI adoption among Basic Science teachers in Kaduna State. The most pervasive challenge is infrastructure deficiency, with 78% of teachers (n=312) reporting lack of electricity as a primary obstacle. This fundamental limitation creates an insurmountable barrier for most technology integration efforts, particularly in rural areas where power supply is most unreliable. Closely related is the issue of poor internet access, affecting 60% of respondents (n = 240), which severely restricts the use of cloud-based AI educational tools and digital resources. The second major category of challenges revolves around human capacity development, where 65% of teachers (n = 260) identified inadequate training as a critical barrier. This suggests that even when technological infrastructure is available, many educators lack the necessary skills to utilize AI tools in their pedagogy effectively. The resistance to change reported by 41% of teachers (n=164) indicates a significant psychological barrier, likely stemming from insufficient understanding of AI's educational benefits or fear of technological displacement.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026352

Resource scarcity emerges as another substantial challenge, with 37% of teachers (n=148) reporting a complete lack of AI tools in their schools. This deficiency is particularly acute in public schools, where funding for educational technology is typically limited.

Institutional Support and Professional Development

Table 4: Availability of Institutional Support (N=400)

Support Type	Frequency (n)	Percentage (%)
AI Workshops Attended	100	25%
Access to AI Tools	60	15%
School AI Policy	20	5%
No Support Received	360	90%

The data paints a concerning picture of institutional support for AI integration in Basic Science education, revealing systemic deficiencies that hinder technological progress in classrooms. A staggering 90% of teachers report receiving no support whatsoever, indicating a near-complete institutional failure to prepare educators for the digital age. The limited support that exists remains woefully inadequate - only one-quarter of teachers have attended AI workshops, a mere 15% have access to AI tools, and just 5% work in schools with any formal AI policy. These findings suggest that the few existing support mechanisms are fragmented, inconsistent, and lack strategic direction. The overwhelming lack of institutional backing creates an impossible environment for successful AI integration, regardless of individual teachers' capabilities or motivation. This systemic neglect stems from multiple root causes: severe resource constraints, misaligned spending priorities, and a fundamental lack of awareness among school leadership about AI's educational value. The near-total absence of institutional policies (95% of schools lacking them) means there are no frameworks to guide implementation, allocate resources effectively, or measure progress. This policy vacuum results in haphazard, uncoordinated efforts that fail to produce meaningful change. To address this crisis, education authorities must immediately implement mandatory AI policies for all schools, establish structured support systems with dedicated funding, and create accountability measures to track progress. Without first building these fundamental institutional frameworks, efforts to improve infrastructure or provide teacher training will remain ineffective and unsustainable. The data clearly shows that institutional support is the foundational barrier that must be addressed before any other AI integration challenges can be meaningfully tackled.

Table 5: Inferential Statistical Analysis of AI Integration Factors

Analysis	Variables Compared	Test Statistic	p-value	Effect Size	Interpretation
Independent t-test	Institutional Support × Location (Urban/Rural)	$x^2(1) = 12.40$	<0.001	Cramer's V = 0.22	Urban schools provide more support (30%) than rural (8%).
	AI Preparedness × Location (Urban/Rural)	$t(398) = 4.12$	<0.001	Cohen's d = 0.52	Urban teachers (M=3.8) are more prepared than rural (M=3.2).
	Confidence in AI × School Type (Public/Private)	$t(398) = 3.85$	<0.001	Cohen's d = 0.48	Private school teachers (M=3.5) report higher confidence than public (M=2.7).

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026352

One-way ANOVA	Institutional Support × Experience (1–5/6–10/11+ yrs)	F(2,397) = 6.94	0.001	$\eta^2 = 0.08$	Teachers with 6–10 years' experience receive significantly more support ($p<0.05$).

Key Notes:

Effect Size Interpretation: Cramer's V: 0.1 (small), 0.3 (medium), 0.5 (large); **Cohen's d:** 0.2 (small), 0.5 (medium), 0.8 (large); **η² (Eta-squared):** 0.01 (small), 0.06 (medium), 0.14 (large); **Statistical Significance:** All tests are significant (*p* < .05), confirming observed differences are unlikely due to chance.

Practical Implications: School type and location significantly predict AI adoption and preparedness.; Mid-career teachers (6–10 years) receive the most institutional support, suggesting targeted policies for other groups.

Qualitative Data Analysis (Thematic Approach)

Emerging Themes

1. **Infrastructure Barriers** (70% of respondents)

"We received tablets, but no electricity to charge them." (Teacher #12, Rural Public School)

"Internet is too slow for AI applications." (Teacher #45, Urban Private School)

2. **Training and Skill Gaps** (65%)

"The one-day workshop was too basic we need hands-on practice." (Teacher #78, Urban Public School)

3. **Fear and Resistance** (41%)

"Will AI replace us? Nobody explains how it helps teaching." (Teacher #33, Rural Private School)

4. **Policy and Leadership Gaps** (55%)

"Our principal doesn't prioritize technology only exam results matter." (Teacher #92, Urban Public School)

Triangulation of Findings

Quantitative Data	Qualitative Support	Conclusion
Low AI adoption in public schools (18%)	*"No funding for AI tools in government schools."*	**Systemic neglect**
Urban teachers more prepared (M=3.8 vs. M=2.7)	*"I learn from YouTube since my school offers no training."*	**Self-driven upskilling**

Discussion of Findings

The findings of this study align closely with both prior empirical research and established theoretical frameworks, while also highlighting context-specific challenges in Kaduna State. The moderate preparedness levels observed (technical proficiency: M=3.2; pedagogical integration: M=2.8) mirror global studies (e.g., Chiu et al., 2023) but are notably lower than those reported in technologically advanced regions. This discrepancy supports the Diffusion of Innovation (DOI) theory, as Nigeria's educational system appears to lag in the adoption curve, with only early adopters (primarily in private schools) demonstrating meaningful AI integration. The significant urban-rural divide in preparedness ($t = 4.12$, $p < .001$) corroborates Oyelere et al.'s (2023) findings on infrastructure disparities in Sub-Saharan Africa, reinforcing how geographical inequities exacerbate technological marginalization.

The infrastructure challenges, particularly electricity shortages (78%) and poor internet access (60%), echo UNESCO's (2023) reports on low-resource settings, but are more severe in Kaduna compared to neighboring Kenya, where solar-powered solutions have mitigated some of these barriers. These systemic gaps directly inhibit the Technological Pedagogical Content Knowledge

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026352

(TPACK) framework's implementation, as teachers cannot apply technological knowledge (TK) without reliable electricity a foundational prerequisite absent in most schools.

The lack of institutional support (90% of teachers unsupported) starkly contrasts with Brazil's success in AI integration (Pedro et al., 2019), where government-mandated policies and funding led to 70% teacher participation in AI programs. This validates DOI's emphasis on institutional factors as critical for mass adoption. Meanwhile, the psychological resistance (41%) aligns with Selwyn's (2023) work on techno-skepticism among educators but is higher than in India (Kumar et al., 2021: 28%), suggesting cultural and contextual nuances in technology acceptance.

CONCLUSION

This study assessed the preparedness of Basic Science teachers in Kaduna State to utilize AI tools, identifying critical challenges and institutional support gaps. The findings reveal moderate technical proficiency but low pedagogical integration, highlighting a significant disconnect between teachers' ability to operate AI tools and their capacity to incorporate them into lesson delivery effectively. The most pervasive barriers are electricity shortages (78%), inadequate training (65%), and lack of institutional policies (90%), demonstrating systemic failures that hinder AI adoption. These results align with the Technological Pedagogical Content Knowledge (TPACK) framework, confirming that successful AI integration requires more than just technical skills; it demands pedagogical adaptation and institutional support. Additionally, the Diffusion of Innovation (DOI) theory explains why adoption remains limited to early adopters (primarily private schools), as infrastructural and policy gaps stall broader implementation.

Recommendations

1. Government must prioritize developing a national AI education framework with dedicated funding for infrastructure and teacher training.
2. Immediate steps should include providing solar-powered solutions for UBE schools and subsidizing internet access.
3. Establish AI implementation committees and create supportive environments that encourage teacher innovation through mentoring programs and incentives.
4. Redesigned to focus equally on technical skills and pedagogical integration, using blended formats accessible to rural educators.
5. Address psychological barriers by clearly positioning AI as a teaching aid rather than a replacement.
6. Piloting context-appropriate solutions like offline AI tools and advocating for equitable resource distribution.
7. Coordinated, sustained efforts across all stakeholders.
8. While the challenges are significant, the moderate baseline preparedness of teachers offers a foundation for progress.
9. By systematically addressing infrastructure gaps, strengthening institutional support, and empowering educators through targeted professional development, Kaduna State can harness AI's potential to transform Basic Science education.
10. This study provides both a sobering assessment of current limitations and a practical road map for meaningful improvement, emphasizing that technological integration must be grounded in realistic appraisals of local contexts and systemic capabilities.
11. The time for isolated interventions has passed, what is needed now is comprehensive, policy-driven reform that creates an enabling environment for sustainable AI adoption in education.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026352

References

Adewumi, O., Onojah, A., & Ameh, O. (2023). Nigerian teachers' AI readiness: A survey of science educators. *African Journal of Educational Technology, 12*(2), 45-60.

Aliyu, M. & Babalola, V. T. (2014). *Basic Education System wastages and socioeconomic development in Nigeria.Onitsha*: West and Solomon Coy Ltd.

Atadoga, M., Ojebisi, A., & Falode, O. (2024). AI in education: Prospects and challenges. Springer.

Babalola, V. T., Ahmad, S. S.,&Tafida, H. S. (2024). ChatGPT in Organic chemistry classrooms: Analysing the impact of social environment on students interest, Critical-thinking and academic achievement, *International Journal of Education and Teaching Zone.* 3(1), 60-72.

Babalola, V. T. (2015). Basic Education for Nigerian socioeconomic development:An exposition of Philippines Barrio School Approach. *Review of Public Administration and management 3(7),68-81.*

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Chen, X., Zou, D., Xie, H., & Wang, F. L. (2020). AI tools for science education. *Journal of Educational Technology, 45*(2), 123-140.

Chiu, T. K. F. (2023). AI in science classrooms: A global review. *Computers & Education, 190*, 104800.

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE.

Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). SAGE.

Holmes, W., Bialik, M., & Fadel, C. (2023). *Artificial intelligence in education.* Center for Curriculum Redesign.

Hwang, G.-J., & Tu, Y.-F. (2023). The roles of teachers in AI-supported classrooms. *Educational Technology Research and Development, 71*(1), 23-42.

Kumar, V., Sharma, R., & Patil, P. P. (2021). AI adoption in Indian schools: Challenges and opportunities. *Journal of Educational Technology Research, 39*(4), 567-589.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *AI for school teachers.* Routledge.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2020). *Qualitative data analysis: A methods sourcebook* (4th ed.). SAGE.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017-1054.

Ogunleye, A. (2023). Policy gaps in Nigeria's AI education strategy. *Journal of Science Policy & Governance, 5*(1), 1-15.

Omagwu, A., Lawal, N. I.,Babalola, V. T. & Obeda, G. (2025).Evaluating Teacher's Qualification and availability of Instructional Materials for Basic Science Curriculum Implementation among Universal Basic Education Schools in Benue State. *Zamfara International Journal of Science Technical Education and Mathematics,* 2(1), 359-374.

Oyelere, S. S., Suhonen, J., & Laine, T. H. (2020). Barriers to AI adoption in Nigerian schools. *African Journal of STEM Education, 8*(1), 55-70.

Pedro, F., Subosa, M., Rivas, A., & Valverde, P. (2019). Institutional support for AI integration in Brazilian schools. *Computers & Education, 135*, 1-12.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

Selwyn, N. (2019). Should robots replace teachers? *AI and the future of education.* Polity Press.

UNESCO. (2021). *AI and education: Policy guidelines.* UNESCO Publishing.

UNESCO. (2023). *AI in African education: Lessons from Kenya.* UNESCO Publishing.

Wang, Y., Liu, C., & Tu, Y.-F. (2023). Virtual labs and AI in STEM education. *British Journal of Educational Technology, 54*(3), 789-805.

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of AI in higher education. *International Journal of Educational Technology in Higher Education, 16*(1), 1-27.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026353

Evaluation of Artificial Intelligence Tools Integration among Pre- Service Biology Teachers: A Case Study of Federal University of Education, Zaria, Kaduna State, Nigeria

MUSA, Hauwa Rabiu[1]
mumbilly882@gmail.com
09075549594

ISAH, Aishat Yakubu[1]
ozuchu@yahoo.com
08065332692

OLAITAN, Aisha Salau[1]
Olaitanaisha7@gmail.com
08036960603

[1]Department of Biology, Federal University of Education, Zaria, Kaduna State, Nigeria

Abstract

The study evaluated the integration of artificial intelligence (AI) tools among in pre-service Biology teachers in Federal University of Education, Zaria Kaduna State. The study was guided by four research objectives with corresponding research questions and null hypotheses, respectively. A descriptive survey research design was used for the study. The population of the study were all pre-service Biology students during the 2024/2025 academic session in Federal University of Education, Zaria. Kaduna State. A sample size of 225 pre-service Biology students were selected from the target population using simple random sampling technique. Data were collected using a structured instrument titled Challenges and Opportunities of Artificial Intelligence in Pre-service Biology Teacher Education Questionnaire (COAIPBTEQ) with a reliability coefficient of 0.88. inferential statistics (t-test) were used to test the null hypotheses. Findings of the study revealed that there was no statistically significant relationship between the level of awareness and the use of AI tools among pre-service Biology teachers ($r = –0.101$, $p > 0.05$). However, a significant difference was found between institutions with high and low levels of support for AI integration ($p < 0.05$). Additionally, a significant gender difference was observed in AI tool usage ($p < 0.05$), with male students showing higher usage rates than their female counterparts. Based on these findings, the study recommends that the government and educational institutions, such as the Federal University of Education, Zaria, invest in digital infrastructure, including reliable internet connectivity, smart classrooms, and AI-enabled platforms, to enhance the integration and effective use of AI in teacher education.

Keywords: Artificial Intelligence Tools, Pre-service Biology Teachers, Federal University of Education Zaria

Introduction

The integration of Artificial Intelligence (AI) into teacher education has rapidly transformed pedagogical practices across disciplines, including science education. In particular, Biology, a subject deeply rooted in empirical inquiry and conceptual visualization, stands to benefit significantly from AI-enhanced learning environments. Pre-service teacher education, which prepares student-teachers for the complexities of real-world classrooms, now faces the imperative of equipping future Biology educators with the technological competence and pedagogical flexibility needed to navigate AI-driven educational tools (Suryawanshi et al., 2023; Zhang et al., 2022). Artificial Intelligence, encompassing technologies such as machine learning, natural language processing, and intelligent tutoring systems, offers immense potential in Biology education. AI tools

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026353

can enhance visualization of complex biological processes, provide real-time feedback through adaptive learning platforms, and simulate laboratory environments for experiential learning (Chukwudi & Kalu, 2020; Okonkwo et al., 2022). These tools not only support differentiated instruction but also foster independent inquiry and critical thinking skills, which are central to Biology pedagogy. Moreover, AI can assist pre-service Biology teachers in lesson planning, automated assessment, and classroom management, thereby improving their instructional efficiency and confidence (Obielodan et al., 2023; Shu & Guo, 2021). Despite these opportunities, the integration of AI in pre-service Biology teacher education faces several challenges. One major concern is the limited access to AI infrastructure and tools, especially in developing contexts such as sub-Saharan Africa, where teacher education programs often lack sufficient funding and digital resources (Ede & Ndudi, 2019; Uchenna & Mohammed, 2021). Additionally, many teacher training institutions have not fully integrated AI competencies into their curricula, resulting in gaps in technological pedagogical content knowledge (TPACK) among student-teachers (Olalekan & Salami, 2022). Another challenge is the resistance to change due to lack of awareness, technical expertise, or institutional support, which can hinder the effective adoption of AI in teacher preparation programs (Afolabi & Odeyemi, 2021; Alhassan & Nwokedi, 2023). Ethical concerns also emerge with the adoption of AI in education. Issues such as data privacy, algorithmic bias, and over-reliance on technology present critical risks that pre-service Biology teachers must be trained to recognize and navigate (Yakubu & Bello, 2023; UNESCO, 2021). These challenges underscore the need for teacher education programs to adopt a balanced and critical approach to AI integration—one that not only emphasizes technological skills but also fosters reflective practice and ethical awareness. Nonetheless, the opportunities for innovation and transformation in Biology teacher education are profound. Integrating AI can bridge gaps in instructional delivery, particularly in contexts with teacher shortages or limited laboratory infrastructure (Ajayi et al., 2020). AI-driven platforms can personalize learning for pre-service teachers, allowing them to progress at their own pace and revisit difficult content areas. Furthermore, AI can facilitate micro-teaching simulations and virtual classroom experiences, offering student-teachers practical exposure in a risk-free environment (Chen et al., 2019; Musa & Omotayo, 2023). Examining the opportunities and problems posed by AI in pre-service biology teacher preparation is crucial given the dual realities of potential and constraint. In order to prepare aspiring biology teachers for the digital era, responsive teacher education policies, curricula, and support systems can be developed with a sophisticated awareness of these dynamics. Preparing pre-service teachers to ethically and effectively utilize AI's potential is still a top concern for sustainable science education reform, as the technology continues to transform educational environments around the world (World Bank, 2023; Nwakpa & Udeh, 2024).

Statement of the Problem

The rapid advancement of Artificial Intelligence (AI) in education presents both promise and complexity for teacher preparation programs, especially in science-related disciplines such as Biology. Pre-service Biology teachers must now not only grasp content knowledge and pedagogy but also develop competencies in emerging technologies like AI. However, many teacher education institutions, particularly in developing contexts, struggle with inadequate digital infrastructure, insufficient training on AI tools, and curriculum gaps that limit the exposure of pre-service teachers to AI applications. Moreover, the absence of a structured framework for integrating AI into Biology teacher education leaves student-teachers underprepared for 21st-century classrooms. While the opportunities offered by AI, such as intelligent tutoring systems, virtual labs, and automated assessments, are substantial, barriers such as technical skill deficiencies, lack of institutional support, ethical concerns, and resistance to technological change hinder effective integration. There

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026353

is a need to systematically explore these challenges and opportunities within pre-service Biology teacher education, identify gaps, and recommend sustainable strategies. Without a clear understanding of how AI is being engaged or resisted in these programs, efforts to modernize science education may remain fragmented or ineffective.

Objectives of the Study

The specific objectives are to:

1. Examine the current level of awareness and use of AI tools among pre-service Biology teachers in Federal University of Education, Zaria
2. Identify the challenges faced in integrating AI technologies into Biology teacher education programs in Federal University of Education, Zaria.
3. Investigate the potential benefits and opportunities AI offers for improving pre-service Biology teaching and learning among preservice Teachers in Federal University of Education, Zaria
4. Explore institutional and curriculum-related factors influencing AI adoption in Biology teacher education in Federal University of Education, Zaria

Research Questions

1. What is the current level of awareness and use of AI tools among pre-service Biology teachers in Federal University of Education, Zaria?
2. What are the major challenges faced by pre-service Biology teacher education programs in adopting AI in Federal University of Education, Zaria?
3. What opportunities does AI provide for enhancing the teaching and learning of Biology among pre-service teachers in Federal University of Education, Zaria?
4. How do institutional factors and curriculum content influence the integration of AI into Biology teacher education in Federal University of Education, Zaria?

Research Hypotheses

Ho_1: There is no significant relationship between the level of AI awareness and the use of AI tools among pre-service Biology teachers in Federal University of Education, Zaria.

Ho_2: Institutional support has no significant influence on the integration of AI in pre-service Biology teacher education program in Federal University of Education, Zaria.

Ho_3: There is no significant difference in AI tool usage between male and female pre-service Biology teachers in Federal University of Education, Zaria.

Research Methodology

This study employed a descriptive survey research design to explore the challenges and opportunities of Artificial Intelligence (AI) in pre-service Biology teacher education. The study was conducted at the Federal University of Education, Zaria, located in Zaria Local Government Area, Kaduna State. The population comprised all pre-service Biology students in Federal University of Education Zaria, during the 2024/2025 academic session. The sample size of 225 students was determined using the Krejcie and Morgan (1970) sample size determination table. A simple random sampling technique was employed to select the participants. Data were collected using a structured questionnaire titled *Challenges and Opportunities of Artificial Intelligence in Pre-service Biology Teacher Education Questionnaire (COAIPBTEQ)*. The instrument was validated by two experts from the Department of Biology, Federal University of Education, Zaria. Reliability of the instrument was determined using the split-half method, yielding a reliability coefficient of 0.88, indicating high internal consistency. The questionnaire was distributed digitally through students' online platforms (such as WhatsApp groups). The responses obtained were evaluated inferential statistics to test the hypotheses.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026353

Presentation of Results

Ho1: There is no significant relationship between the level of AI awareness and the use of AI tools among pre-service Biology teachers in Federal University of Education, Zaria.

Variables Compared	N	Correlation (r)	p-value	Strength	Decision
Awareness and Use Scores	225	–0.101	0.131	Weak/None	N.S.

There is no statistically significant relationship between the level of awareness and the use of AI tools among pre-service Biology teachers ($r = –0.101$, $p > 0.05$). This means being aware of AI does not necessarily translate into using it.

Ho2: Institutional support has no significant influence on the integration of AI in pre-service Biology teacher education in Federal University of Education, Zaria.

Group	N	Mean	SD	t	Df	p-value	Decision
High Institutional Support	112	3.40	0.60	10.04	223	< 0.001	Significant
Low Institutional Support	113	2.80	0.50				

The result of hypothesis H_{02} shows a statistically significant difference between the groups with high and low institutional support regarding the integration of AI in pre-service Biology teacher education. Participants from institutions with high support had a higher mean score ($M = 3.40$, $SD = 0.60$) compared to those with low support ($M = 2.80$, $SD = 0.50$). The t-test yielded a value of $t(223) = 10.04$ with a p-value less than 0.001, indicating that the difference is statistically significant. Therefore, the null hypothesis (H_{02}), which states that institutional support has no significant influence on AI integration, is rejected. This suggests that higher levels of institutional support positively influence the integration of AI in pre-service Biology teacher education.

Ho3: There is no significant difference in AI tool usage between male and female pre-service Biology teachers in Federal University of Education, Zaria.

Gender	N	Mean	SD	t	df	p-value	Decision
Male	120	2.70	0.50	3.91	223	0.0001	Significant
Female	105	2.50	0.50				

The result of hypothesis $H0_3$ indicates a significant gender difference in the use of AI tools among pre-service Biology teachers. Male participants had a higher mean score ($M = 2.70$, $SD = 0.50$) compared to their female counterparts ($M = 2.50$, $SD = 0.50$). The independent t-test yielded a value of $t(223) = 3.91$ with a p-value of 0.0001, which is statistically significant. As a result, the null hypothesis (H_{03}), stating that there is no significant difference in AI tool usage between male and female pre-service Biology teachers, is rejected. This finding suggests that male pre-service teachers use AI tools more frequently than female pre-service teachers.

Discussion of Findings

The finding that there is no statistically significant relationship between pre-service Biology teachers' awareness of AI and their actual use of AI tools ($r = –0.101$, $p > 0.05$) emphasized a disconnect between knowledge and practice in AI integration. This supports the argument by Ede and Ndudi

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026353

(2019), who identified that while Nigerian teacher education programs may discuss AI in theory, they rarely equip students with opportunities for hands-on experience. Olalekan and Salami (2022) echoed this by emphasizing the lack of curriculum components dedicated to AI skill development, resulting in a superficial understanding that rarely translates into practice. Afolabi and Odeyemi (2021) further stressed that resistance to adopting AI stems not from lack of awareness, but from a lack of structured exposure and institutional prioritization. In agreement, Obielodan, Oladejo, and Ayodeji (2023) found that although a significant number of pre-service teachers were aware of tools like ChatGPT and virtual simulations, very few had actually used them in instructional settings. Shu and Guo (2021) emphasized that effective AI implementation requires more than awareness—it demands pedagogical integration strategies and continuous practice. Chen, Xie, and Hwang (2019) reinforced this by presenting a model where AI awareness only led to usage when scaffolded with system-wide institutional support and teacher modeling. Furthermore, Yakubu and Bello (2023) highlighted ethical and cultural concerns, which may make some students hesitant to fully engage with AI despite being aware of its relevance. Overall, the findings reveal that awareness alone is insufficient without structured and experiential learning pathways.

The observed significant difference in AI integration between students with high and low institutional support ($p < 0.05$) confirms the central role institutions play in enabling or hindering AI adoption in teacher education. According to Musa and Omotayo (2023), Nigerian universities with investments in virtual reality, smart classrooms, and instructor training report higher rates of AI use and confidence among their students. Ajayi, Bakare, and Ogunleye (2020) similarly observed that the availability of AI-enabled platforms enhances science learning engagement in institutions with better digital infrastructure. Nwakpa and Udeh (2024) emphasized the importance of institutional policy frameworks that support AI in science education, noting that students thrive better when systems provide both digital tools and guidelines for use. UNESCO (2021) and the World Bank (2023) have also recognized institutional readiness as a foundational element of successful AI integration, especially in developing nations. Alhassan and Nwokedi (2023) reported that many institutions in sub-Saharan Africa still lag in AI readiness due to infrastructural gaps and policy inertia. Afolabi and Odeyemi (2021) also found that institutions with proactive leadership and investment in faculty AI training were more likely to foster meaningful student engagement. This finding aligns with Okonkwo, Etuk, and Ebong (2022), who noted that intelligent tutoring systems and adaptive learning platforms are only effective when institutions provide structured, consistent access and support mechanisms. The study revealed a significant gender difference in AI tool usage, with male students using AI tools more frequently than female students ($p < 0.05$). This confirms longstanding concerns about gender gaps in digital literacy and access. Chukwudi and Kalu (2020) observed that male pre-service Biology teachers in Nigerian colleges were more likely to explore new AI technologies, partly due to societal encouragement toward technical fields. Similarly, Olalekan and Salami (2022) noted that female students often experience lower confidence in handling digital tools due to early exposure disparities and lack of targeted encouragement. Afolabi and Odeyemi (2021) emphasized the importance of creating inclusive digital learning environments that deliberately engage female students in AI training activities. Yakubu and Bello (2023) pointed out that ethical concerns, intimidation in male-dominated tech spaces, and a lack of female role models in educational technology contribute to the gap. Alhassan and Nwokedi (2023) also found that gender disparities in AI use persist across institutions unless addressed through specific interventions. Globally, UNESCO (2021) has called for equity-driven digital education strategies, warning that AI could worsen gender inequalities if access, content, and instruction are not made gender-inclusive. Suryawanshi,

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026353

Bhutada, and Kadam (2023) further emphasized the need for gender-sensitive design in AI learning platforms to accommodate different user experiences. This finding reaffirms the urgent need for intentional, gender-responsive digital inclusion policies in teacher education. The integration of AI into pre-service Biology education holds significant potential to transform teaching and learning processes. Supporters argue that AI can personalize learning experiences, provide intelligent tutoring systems, and facilitate access to rich multimedia resources that enhance conceptual understanding (Luckin et al., 2016; Holmes et al., 2019). For instance, AI-powered simulations can help pre-service teachers visualize complex biological processes, improving their instructional skills before entering real classrooms (Chen et al., 2020). Furthermore, AI can automate assessment and feedback, allowing for more timely and targeted interventions (Woolf, 2010). On the other hand, critics caution that over-reliance on AI tools may diminish essential human elements of teaching, such as empathy and contextual judgment, which are critical in Biology education (Selwyn, 2019). Additionally, infrastructural challenges and limited AI literacy among pre-service teachers may hinder effective implementation (Afolabi & Odeyemi, 2021). There are also concerns about data privacy and the ethical implications of AI in educational settings (Williamson & Piattoeva, 2020). Despite these challenges, the potential benefits of AI in pre-service Biology teaching—ranging from enhanced engagement and individualized support to efficient resource management—warrant thorough investigation to guide effective integration and policy formulation.

Conclusion

This study examined the challenges and opportunities of Artificial Intelligence (AI) integration in pre-service Biology teacher education, with a focus on awareness, usage, institutional support, and gender disparities. One of the key findings revealed that while many pre-service teachers were aware of AI as a concept, this awareness did not significantly translate into the actual use of AI tools. This indicates a critical disconnect between theoretical exposure and practical application, highlighting the need for experiential and skill-based AI training. The gap suggests that awareness campaigns alone are insufficient without hands-on opportunities that foster confidence and competence. Furthermore, the study found that institutional support plays a significant role in AI adoption. Students from institutions with strong infrastructure, policies, and faculty support were more likely to engage with AI in meaningful ways. In contrast, poor access to AI resources and lack of structured training in less-equipped institutions posed significant barriers. Additionally, a notable gender gap in AI usage was observed, with male students engaging more frequently with AI tools than female students. This finding underscores the urgent need for gender-responsive digital literacy programs to ensure equitable participation in AI-enhanced teacher education.

Recommendations

1. Curriculum planners should embed practical AI applications, simulations, and tool-based workshops into Biology teacher education programs.
2. Government and educational institutions like FUE Zaria should invest in digital infrastructure such as internet connectivity, smart classrooms, and AI-enabled platforms.
3. To close the gender gap in AI usage, targeted interventions such as mentorship for female students, inclusive digital skills workshops, and equitable access to AI tools should be prioritized.

References

Afolabi, S. S., & Odeyemi, K. O. (2021). Challenges of adopting artificial intelligence in Nigerian teacher education. *Nigerian Journal of Educational Technology*, 14(2), 45–56.

Ajayi, A. O., Bakare, T. A., & Ogunleye, J. O. (2020). AI-enabled learning in science classrooms: Potentials for Nigeria's pre-service education. *African Journal of Educational Studies*, 8(1), 65–78.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026353

Alhassan, R. A., & Nwokedi, E. M. (2023). Readiness of teacher education institutions in adopting AI for instructional delivery. *Contemporary Issues in Education*, 21(4), 123–136.

Chen, X., Xie, H., & Hwang, G. J. (2019). A blockchain-based framework for AI-driven smart learning environments. *Interactive Learning Environments*, 27(8), 1046–1059.

Chen, X., Xie, H., Zou, D., & Hwang, G. J. (2020). Application and theory gaps during the rise of artificial intelligence in education. *Computers & Education, 146*, 103751. https://doi.org/10.1016/j.compedu.2019.103751

Chukwudi, A. & Kalu, O. (2020). Prospects of artificial intelligence in Biology education in Nigerian colleges of education. *Journal of Biology and Science Pedagogy*, 7(3), 101–112.

Ede, M. O., & Ndudi, B. E. (2019). Barriers to ICT adoption in Nigerian teacher education programs. *International Journal of Educational Management*, 18(2), 89–101.

Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial intelligence in education: Promises and implications for teaching and learning*. Boston, MA: Center for Curriculum Redesign.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence unleashed: An argument for AI in education*. Pearson Education.

Musa, R. T., & Omotayo, L. F. (2023). Virtual reality and AI tools for science teacher preparation: A case study of Nigerian universities. *Journal of Digital Education and Smart Learning*, 9(1), 15–29.

Nwakpa, P. O., & Udeh, G. I. (2024). Enhancing science education in Nigeria through artificial intelligence: Policy options and training models. *Nigerian Journal of Science Education Research*, 12(2), 33–49.

Obielodan, B. A., Oladejo, M. A., & Ayodeji, I. F. (2023). Pre-service teachers' competence and perception of AI tools in teaching biology. *Journal of Instructional Innovation in Science Education*, 5(2), 47–61.

Okonkwo, C. N., Etuk, E. B., & Ebong, E. E. (2022). Artificial intelligence and intelligent tutoring systems: An opportunity for transforming teacher education. *African Journal of Educational Technology*, 10(1), 24–39.

Olalekan, O. A., & Salami, R. K. (2022). Curriculum gaps in pre-service teacher training on digital skills and AI integration. *Journal of Education Policy and Digital Transformation*, 6(4), 78–91.

Selwyn, N. (2019). *Should robots replace teachers? AI and the future of education*. Polity Press.

Shu, H., & Guo, H. (2021). Teaching in the age of artificial intelligence: Implications for teacher education. *Computers & Education*, 161, 104094.

Suryawanshi, D., Bhutada, S., & Kadam, A. (2023). AI in science education: Opportunities, challenges, and future directions. *International Journal of STEM Education*, 10(1), 45–58.

UNESCO. (2021). *AI and Education: Guidance for policy-makers*. Paris: United Nations Educational, Scientific and Cultural Organization.

Williamson, B., & Piattoeva, N. (2020). Objectivity as standardization in data-scientific educational governance: Grasping the global through the local. *Education Policy Analysis Archives*, *28*(51), 1–25.

Woolf, B. P. (2010). *Building intelligent interactive tutors: Student-centered strategies for revolutionizing e-learning*. Morgan Kaufmann.

World Bank. (2023). *Transforming Education Systems with Artificial Intelligence: A Framework for Action*. Washington, DC: World Bank Publications.

Yakubu, Y. S., & Bello, T. O. (2023). Ethical implications of AI in Nigerian teacher education. *Journal of Educational Ethics and Innovation*, 7(3), 109–122.

Zhang, Y., Lin, P., & Yu, Z. (2022). Integrating artificial intelligence in science teacher training: A systematic review. *Teaching and Teacher Education*, 117, 103828.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026354

Effect of Rehabilitation Counselling Intervention on Academic Adjustment among Learners with Special Needs in Mainstream Secondary Schools in Zaria, Kaduna State, Nigeria

DALHATU, Mohammed Nuraddeen
nuradeendalhatu@yahoo.com
08035957775

Nigerian Navy Basic Training School, Onne

Abstract

Inclusive education has increased the presence of learners with special needs in mainstream secondary schools, thereby necessitating effective psychosocial and academic support mechanisms. Rehabilitation counselling interventions have emerged as an important strategy for helping learners with disabilities cope with academic, emotional, and social challenges in inclusive school environments. This study examined how rehabilitation therapy treatments affected special needs students' academic adjustment in mainstream secondary schools in Zaria, Kaduna State. A descriptive survey design was used in the study. 85 students with recognized special needs from sampled secondary schools made up the sample of the study. A structured questionnaire was used to collect data on rehabilitation counselling interventions and academic adjustment indicators such as study habits, classroom participation, and emotional stability. Data were analyzed using mean, standard deviation, and inferential statistics. Findings revealed that academic counselling interventions have a significant effect on the study habits of learners with special needs in mainstream secondary schools (p=0.017<0.05), psychosocial counselling interventions have a significant influence on classroom participation among learners with special needs in mainstream secondary schools (p=0.034<0.05), behavioral counselling interventions have a significant effect on the emotional stability of learners with special needs in mainstream secondary schools (p=0.019<0.05), and there is a moderate positive relationship between rehabilitation counselling interventions and academic adjustment of learners with special needs (r=0.56 and p=0.000). The study concluded that counselling-based rehabilitation services are essential for promoting inclusive education and enhancing the academic functioning of learners with disabilities. The study recommended that Government and educational authorities should ensure the deployment of trained rehabilitation counsellors in mainstream secondary schools to provide specialized support for learners with special needs, among others.

Keywords: Rehabilitation Counselling, Academic Adjustment, Learners with Special Needs, Mainstream Secondary Schools

Introduction

Education systems around the world have increasingly embraced the philosophy of inclusive education, which promotes the integration of learners with special needs into mainstream schools. Inclusive education seeks to ensure that all learners, regardless of disability or learning challenges, have equal opportunities to participate in quality education alongside their peers. This approach recognizes diversity in learners' abilities and emphasizes the provision of support services that facilitate effective learning and social participation. In many countries, inclusive education policies encourage schools to provide specialized support services such as counselling, individualized instruction, and psychosocial assistance to enhance the learning experiences of students with disabilities (Ainscow, 2020; Florian, 2022; UNESCO, 2020). Learners with special needs often experience significant academic and psychosocial challenges when placed in mainstream educational settings. These challenges may include difficulties in academic performance, low self-esteem, social isolation, emotional distress, and limited participation in classroom activities. Such difficulties can hinder their ability to adjust academically and socially within the school environment. Consequently,

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026354

the success of inclusive education largely depends on the availability of supportive interventions that address both academic and emotional needs of these learners. Educational support services such as counselling, specialized instruction, and psychological support have been identified as critical components for helping learners with disabilities achieve their full academic and social potential (Mitchell, 2020; Slee, 2021; Muralidhar et al., 2024). Rehabilitation counselling has emerged as one of the most important support mechanisms for learners with special needs in inclusive school environments. Rehabilitation counselling focuses on helping individuals with disabilities develop coping strategies, enhance self-concept, overcome psychological barriers, and improve their functional abilities in academic and social contexts. Through interventions such as academic counselling, behavioural therapy, social skills training, and career guidance, rehabilitation counselling supports learners in adapting to the demands of mainstream schooling. These interventions aim to empower learners with disabilities by promoting self-confidence, independence, and effective learning behaviours (Chan, Tarvydas, & Blalock, 2021; Parker & Szymanski, 2004). Studies have demonstrated that counselling interventions can significantly improve the emotional well-being and academic functioning of learners with special needs. For instance, counselling services have been found to reduce academic stress, enhance study habits, and improve learners' confidence in their academic abilities. Similarly, counselling interventions can strengthen students' social skills and emotional regulation, which are essential for successful participation in inclusive educational environments. Such improvements contribute positively to learners' overall academic adjustment and engagement in school activities (Acosta-Gonzaga, 2023; Richardson, Abraham, & Bond, 2021). Furthermore, intervention-based studies have shown that structured classroom or psychosocial support programmes can significantly enhance the social and adaptive skills of learners with disabilities. For example, social skills training programmes implemented in educational settings have been shown to improve interaction skills and reduce behavioural difficulties among students with intellectual disabilities. These improvements highlight the importance of targeted support interventions in promoting effective academic participation and adjustment among learners with special needs (Gresham, Sugai, & Horner, 2020; Muralidhar et al., 2024). Despite the growing recognition of inclusive education in Nigeria, many mainstream secondary schools still face challenges in providing adequate rehabilitation and counselling services for learners with disabilities. Limited availability of trained counsellors, insufficient educational resources, and inadequate awareness of inclusive practices often hinder the effective implementation of support interventions for learners with special needs. As a result, many learners struggle to adapt academically and socially within mainstream school environments (Angwaomaodoko, 2023; Nawait & Mustapha, 2025). In Kaduna State, mainstream secondary schools increasingly enroll learners with diverse disabilities and learning challenges. However, there is limited empirical evidence regarding the effectiveness of rehabilitation counselling interventions in facilitating the academic adjustment of these learners. Therefore, it is crucial to comprehend the function of counseling-based rehabilitation services in order to enhance inclusive education practices and guarantee that students with unique needs acquire the assistance they require to achieve academic success. It is against this background that this study investigates the effect of rehabilitation counselling interventions on the academic adjustment of learners with special needs in mainstream secondary schools within Zaria, Kaduna State.

Statement of the Problem

The global movement toward inclusive education has led to the increasing integration of learners with special needs into mainstream secondary schools. This approach aims to promote equal educational opportunities and social inclusion for all learners regardless of disability. However, the

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026354

placement of learners with disabilities in mainstream classrooms does not automatically ensure successful academic participation or adjustment. Many learners with special needs experience difficulties adapting to the academic demands, social expectations, and psychological pressures of mainstream school environments (Ainscow, 2020; Florian, 2022). For learners with special needs, achieving academic adjustment can be particularly challenging due to factors such as learning difficulties, communication barriers, low self-esteem, social stigma, and inadequate instructional support. Without appropriate support systems, these learners may experience poor academic performance, low engagement in learning activities, and a higher risk of school dropout (Mitchell, 2020; Slee, 2021). Rehabilitation counselling interventions have been identified as an important strategy for addressing the academic and psychosocial challenges faced by learners with disabilities. However, many mainstream secondary schools in Nigeria lack adequate counselling services specifically designed to support learners with special needs, often due to shortages of trained counsellors and limited educational resources. In Kaduna State and Zaria in particular, the enrollment of learners with special needs in mainstream secondary schools has increased as a result of inclusive education initiatives. Despite this development, there is limited empirical evidence on how rehabilitation counselling interventions influence the academic adjustment of these learners. This lack of evidence makes it difficult for educators and policymakers to design effective support programmes. It is therefore necessary to investigate the effect of rehabilitation counselling interventions on the academic adjustment of learners with special needs in mainstream secondary schools within Zaria, Kaduna State.

Objectives of the Study

The Specific objectives of the study are to:

1. Determine the level of availability of rehabilitation counselling interventions for learners with special needs in mainstream secondary schools in Zaria.
2. Examine the effect of academic counselling interventions on the study habits of learners with special needs.
3. Investigate the influence of psychosocial counselling interventions on the classroom participation of learners with special needs.
4. Determine the effect of behavioural counselling interventions on the emotional stability of learners with special needs.
5. Examine the overall relationship between rehabilitation counselling interventions and academic adjustment of learners with special needs.

Research Hypotheses

At the 0.05 level of significance, the following null hypotheses were examined:

Ho_1: There is no significant effect of academic counselling interventions on the study habits of learners with special needs in mainstream secondary schools in Zaria.

Ho_2: Psychosocial counselling interventions have no significant influence on classroom participation of learners with special needs in mainstream secondary schools in Zaria.

Ho_3: Behavioural counselling interventions have no significant effect on the emotional stability of learners with special needs in mainstream secondary schools in Zaria.

Ho_4: There is no significant relationship between rehabilitation counselling interventions and academic adjustment of learners with special needs in mainstream secondary schools in Zaria.

Review of Related Literature

Concept of Rehabilitation Counselling

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026354

Rehabilitation counselling is a specialized counselling practice designed to assist individuals with disabilities to achieve optimal levels of personal, social, and academic functioning. The discipline focuses on helping individuals overcome psychological, social, and environmental barriers that may limit their participation in educational and vocational activities. Rehabilitation counsellors work with individuals with disabilities to enhance coping strategies, improve self-concept, and develop adaptive behaviours necessary for independent living and academic success (Chan et al., 2021). In educational settings, rehabilitation counselling interventions include academic guidance, emotional support, behavioural management strategies, and social skills training. These services are particularly important for learners with special needs who often face challenges such as low academic self-efficacy, social stigma, and learning difficulties. According to Parker and Szymanski (2004), rehabilitation counselling in schools aims to empower learners with disabilities by promoting resilience, self-determination, and academic competence. Rehabilitation counselling also emphasizes a holistic approach that addresses both psychological and environmental factors influencing learners' development. Counsellors collaborate with teachers, parents, and school administrators to design individualized support strategies that facilitate students' academic and social integration within mainstream classrooms (Hartley et al., 2021).

Concept of Academic Adjustment

Academic adjustment refers to the ability of learners to effectively adapt to the academic demands and expectations of the educational environment. It encompasses behaviours and attitudes such as motivation to learn, effective study habits, classroom engagement, emotional regulation, and the ability to cope with academic challenges (Credé & Niehorster, 2019). For learners with special needs, academic adjustment is influenced by several factors including cognitive abilities, emotional well-being, availability of learning support services, and the inclusiveness of the school environment. Students who successfully adjust academically tend to demonstrate greater persistence in learning tasks, improved academic performance, and positive relationships with teachers and peers (Richardson, Abraham, & Bond, 2021). However, learners with disabilities may experience difficulties in academic adjustment due to learning barriers, communication challenges, and negative social experiences within the classroom. These challenges highlight the need for supportive interventions such as counselling services to facilitate positive academic adaptation among learners with special needs.

Learners with Special Needs in Inclusive Schools

People who need extra help in school because of physical, sensory, cognitive, emotional, or behavioural impairments are considered learners with special needs. Inclusive education policies advocate for the placement of these learners in mainstream classrooms where they can learn alongside their peers while receiving appropriate support services (Florian, 2022). Research has shown that inclusive education can improve social integration, self-esteem, and academic motivation among learners with disabilities when appropriate support mechanisms are available. However, when support services are inadequate, learners may struggle to cope with academic tasks and social expectations within the school environment (Ainscow, 2020). Teachers and school counsellors therefore play a critical role in facilitating the academic and social adjustment of learners with special needs. Through targeted interventions, educational professionals can help learners overcome barriers to learning and achieve their academic potential.

Research Methodology

The research design used in this study was a descriptive survey. All students in Zaria, Kaduna State's mainstream secondary schools with specified special needs made up the study's population. These learners included students with learning disabilities, visual impairments, hearing impairments, and

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026354

mild physical disabilities who were enrolled in inclusive classrooms. A multi-stage sampling technique was used for the study. First, several mainstream secondary schools that enrolled learners with special needs were purposively selected. Thereafter, eighty-five (85) learners with identified special needs within these schools were selected using simple random sampling. To determine an appropriate sample size, the Krejcie and Morgan (1970) sample size determination table was used. Based on the population of learners with special needs within the selected schools, a representative sample of respondents was drawn for the study to ensure adequate representation and reliability of the results. A self-structured instrument called the "Rehabilitation Counselling Interventions and Academic Adjustment Questionnaire (RCIAAQ)" was used to gather data for the study. The questionnaire comprised two sections: Section A elicited demographic information of the respondents, while Section B contained items designed to measure rehabilitation counselling interventions and academic adjustment among learners with special needs. The items were structured on a four-point Likert scale of Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). The instrument assessed major components of rehabilitation counselling interventions, including academic counselling, psychosocial counselling, and behavioural counselling, while academic adjustment was measured through indicators such as study habits, classroom participation, motivation to learn, and emotional stability. Face, concept, and content validity tests were performed on the instrument. The Cronbach Alpha technique was used to assess the instrument's reliability; a reliability value of 0.88 was found, indicating that the instrument had adequate internal consistency and was thus appropriate for the study. With the help of teachers and school counsellors, the researcher gave the questionnaire to the respondents directly. Descriptive and inferential statistics were used to analyse the data gathered for the study.

Presentation of Results

Table 1: Independent Sample t-test on Academic Counselling and Study Habits

Variable	N	Mean	SD	t-value	Df	p-value	Decision
Academic Counselling	85	3.12	0.78	2.41	168	0.017	Rejected
Study Habits	85	3.05	0.82				

The results in Table 1 indicate that academic counselling interventions have a significant effect on the study habits of learners with special needs in mainstream secondary schools. The mean score for academic counselling was 3.12 (SD = 0.78), while the mean score for study habits was 3.05 (SD = 0.82). The independent samples t-test produced a t-value of 2.41 with 168 degrees of freedom and a p-value of 0.017, which is less than the 0.05 level of significance. Based on this result, the null hypothesis was rejected. This implies that academic counselling interventions significantly improve the study habits of learners with special needs.

Table 2: Independent Sample t-test on Psychosocial Counselling and Classroom Participation

Variable	N	Mean	SD	t-value	df	p-value	Decision
Psychosocial Counselling	85	3.08	0.81	2.13	168	0.034	Rejected
Classroom Participation	85	3.01	0.85				

The results in Table 2 show that psychosocial counselling interventions have a significant influence on classroom participation among learners with special needs in mainstream secondary schools. The mean score for psychosocial counselling was 3.08 (SD = 0.81), while classroom participation had a mean score of 3.01 (SD = 0.85). The independent samples t-test produced a p-value of 0.034, which is below the 0.05 level of significance, and a t-value of 2.13 with 168 degrees of freedom. The null

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026354

hypothesis was thus disproved. This indicates that psychosocial counselling interventions significantly enhance the classroom participation of learners with special needs.

Table 3: Independent Sample t-test on Behavioural Counselling and Emotional Stability

Variable	N	Mean	SD	t-value	df	p-value	Decision
Behavioural Counselling	85	3.10	0.77	2.36	168	0.019	Rejected
Emotional Stability	85	3.04	0.83				

Table 3 indicates that behavioural counselling interventions have a significant effect on the emotional stability of learners with special needs in mainstream secondary schools. The mean score for behavioural counselling was 3.10 (SD = 0.77), while emotional stability had a mean score of 3.04 (SD = 0.83). The independent samples t-test produced a t-value of 2.36 with 168 degrees of freedom and a p-value of 0.019, which is below the 0.05 level of significance. Based on this result, the null hypothesis was rejected. This implies that behavioural counselling interventions significantly improve the emotional stability of learners with special needs.

Table 4: Pearson Product Moment Correlation Showing the Relationship between Rehabilitation Counselling Interventions and Academic Adjustment

Variables	N	Mean	SD	r	p-value	Decision
Rehabilitation Counselling Interventions	85	3.09	0.80	0.56	0.000	Rejected
Academic Adjustment	85	3.04	0.83			

Table 4 shows that the correlation coefficient (r = 0.56) indicates a moderate positive relationship between rehabilitation counselling interventions and academic adjustment of learners with special needs. The null hypothesis is rejected since the p-value (0.000) is below the significance level of 0.05. This suggests that the academic adjustment of students with special needs in Zaria's mainstream secondary schools is greatly impacted by rehabilitative counselling programs.

Discussion of Findings

The findings of this study revealed that rehabilitation counselling interventions significantly contribute to the academic adjustment of learners with special needs in mainstream secondary schools. The results showed that students who received counselling support demonstrated better study habits, increased classroom participation, and improved emotional stability. The study found that academic counselling interventions positively influenced the study habits of learners with special needs. Learners who received guidance on study strategies, time management, and learning techniques were better able to cope with academic tasks. This finding is consistent with the work of Richardson, Abraham, and Bond (2021), who reported that structured academic support improves students' learning strategies and academic engagement. Similarly, Acosta-Gonzaga (2023) found that counselling interventions enhanced academic motivation and study behaviour among students with learning difficulties. Another important finding of the study revealed that psychosocial counselling interventions significantly improved classroom participation among learners with special needs. Students who received emotional support and social skills training were more confident in interacting with teachers and classmates. This result aligns with the findings of Muralidhar et al., (2024), who reported that psychosocial intervention programmes improve social participation and engagement among students with disabilities. The study also found that behavioural counselling interventions enhanced the emotional stability of learners with special needs. Counselling sessions helped students develop coping strategies for managing academic stress, frustration, and anxiety. This

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026354

finding supports the work of Chan, Tarvydas, and Blalock (2021), who noted that rehabilitation counselling promotes emotional resilience and adaptive coping among individuals with disabilities. Furthermore, the study established a significant relationship between rehabilitation counselling interventions and the overall academic adjustment of learners with special needs. Students who benefited from counselling services were better able to adapt to the academic demands of mainstream schooling. This finding supports earlier studies which emphasize the importance of counselling services in inclusive education environments (Ainscow, 2020; Florian, 2022). However, some studies have suggested that counselling services alone may not be sufficient to address the academic challenges of learners with special needs unless they are combined with effective instructional strategies and supportive school environments (Graham, 2020). This implies that counselling interventions should be integrated with broader inclusive education practices.

Conclusion

The results of this study indicate that rehabilitation counselling interventions are important in helping students with special needs adjust academically in mainstream secondary schools. Counselling services help learners develop effective study habits, improve their classroom participation, and manage emotional challenges associated with academic activities. The study further established that counselling interventions enhance learners' self-confidence, coping abilities, and motivation to engage in academic tasks. These factors contribute significantly to their ability to adapt to the academic and social demands of inclusive school environments. Therefore, the integration of structured rehabilitation counselling programmes within mainstream secondary schools is essential for promoting inclusive education and supporting the academic success of learners with special needs.

Recommendations

The study's conclusions led to the following suggestions being made:

1. Government and educational authorities should ensure the deployment of trained rehabilitation counsellors in mainstream secondary schools to provide specialized support for learners with special needs.
2. School administrators should establish structured counselling programmes aimed at improving the academic adjustment of learners with disabilities.
3. Teachers should collaborate with school counsellors to identify learners who require additional psychosocial or academic support.
4. Workshops and training programmes should be organized for teachers to enhance their understanding of inclusive education practices and counselling strategies for supporting learners with special needs.

References

Acosta-Gonzaga, E. (2023). The Effects of Self-Esteem and Academic Engagement on University Students' Performance. *Behavioral Sciences, 13*.

Ainscow, M. (2020). Promoting inclusion and equity in education: Lessons from international experiences. *Nordic Journal of Studies in Educational Policy*, 6(1), 7–16.

Angwaomaodoko, E. A. (2023). The Challenges and Opportunities of Inclusive Education in Nigeria. Path of Science, 9(7), 1001-1009.

Chan, F., Tarvydas, V., & Blalock, K. (2021). *The professional practice of rehabilitation counseling*. Springer Publishing Company.

Credé, M., & Niehorster, S. (2011). Adjustment to College as Measured by the Student Adaptation to College Questionnaire: A Quantitative Review of its Structure and Relationships with Correlates and Consequences. *Educational Psychology Review*, 24(1), 133–165.

Florian, L. (2022). *The Sage handbook of special education* (3rd ed.). Sage Publications.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026354

Graham, L. (2020). Inclusive education in the 21st century. *Educational Philosophy and Theory*, 52(8), 3–26. DOI:10.4324/9781003116073-2

Gresham, F. M., Sugai, G., & Horner, R. (2001). Interpreting outcomes of social skills training for students with disabilities. *Exceptional Children, 67*, 331–344.

Hartley, M. T., Peterson, D., & Fennie, C. (2021). Technology ethics and distance counseling. In C. C. Cottone, V. M. Tarvydas, & M. T. Hartley (Eds.), *Ethics and decision making in counseling and psychotherapy* (5th ed., pp. 351–376). Springer.

Mitchell, D. (2020). *What really works in special and inclusive education* (3rd ed.). Routledge.

Muralidhar M, Spector A, Hui EK, Liu L, Ali A. (2024). A systematic review of psychosocial interventions for people with intellectual disabilities and dementia. *Aging Ment Health*;28(3):385-395. doi: 10.1080/13607863.2023.2265322.

Nawait, M. S. & Mustapha, A. (2025). Guidance and Counselling Services and Mental Well-Being of Individuals with Special Needs in A.A. Raji Special School Sokoto. *Rima International Journal of Education*, 4(4), 246-258

Parker, R. M., & Szymanski, E. M. (2004). *Rehabilitation counseling: Basics and beyond* (4th ed.). Pro-Ed.

Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of academic performance: A systematic review and meta-analysis. *Psychological Bulletin*, 138(2), 353–387.

Slee, R. (2021). *Inclusive education isn't dead; it just smells funny*. Routledge.

UNESCO. (2020). *Global education monitoring report: Inclusion and education – All means all*. UNESCO Publishing.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026355

Qualitative Study of E-Learning Tools Utilization on Productivity Level among Extension Agents in Nigeria: A Systematic Approach

ADEBAYO, Mutalib
adebayomutalib1595@gmail.com
+2348033528706

Department of Adult and Continuing Education, Federal University of Education, Zaria, Kaduna State, Nigeria

Abstract

The increasing complexity of extension services has intensified the need for continuous professional development among extension agents. Considering the significance of extension agents as critical intermediaries linking research institutions, government agencies, and rural communities makes improving professional competence in line with occupational demands of extension agents very imperative. With advancement in Information and Communication Technology (ICT) transforming learning processes and professional development practices across various sectors, e-learning has emerged as a transformative tool for enhancing knowledge acquisition, professional development, and productivity of extension agents. Therefore, this paper, anchored on the Human Capital Theory, discussed the role of e-learning tools in enhancing productivity of extension agents in Nigeria. The paper examined the concepts of e-learning, explored the functions of extension agents, and analysed the potential of e-learning tools in strengthening professional competence of extension agents. The paper also identified challenges constraining the effective utilisation of e-learning platforms by extension agents in Nigeria. Such challenges include inadequate ICT infrastructure, poor internet connectivity, limited digital literacy, and insufficient institutional support mechanisms. The paper argued that integrating e-learning into extension training frameworks can significantly improve knowledge dissemination, professional capacity, and service delivery to communities. Hence, the paper recommended the need for adoption of blended learning approaches, institutional collaboration between extension organisations and educational institutions, and the development of specialised digital learning platforms tailored to extension work.

Keywords: E-learning, Extension agents, Extension services, Productivity, and Utilisation

Introduction

Extension services are essential component of community development in developing countries. As an institutional mechanism through which knowledge, technologies, and innovations generated by research institutions are transferred to communities, extension services strengthening community capacities, and enhance socio-economic wellbeing of communities especially in the rural areas (Chiagorom et al., 2023; Yakubu et al, 2025). In Nigeria, extension services are particularly significant because a large proportion of the population depends on agriculture and rural livelihood systems for survival and economic stability. Effectiveness of extension programmes in achieving expected objectives largely depends on the competence, motivation, and productivity of extension agents who serve as the primary interface between research institutions, government agencies, and rural communities. Despite the strategic importance of extension agents, Anderson and Feder (2007) observe that extension services in many developing countries, Nigeria inclusive, face persistent challenges related to inadequate professional development opportunities, weak institutional support, and limited access to updated knowledge resources. These challenges often translate into reduced productivity and limited capacity among extension agents to effectively deliver extension services. Extension services are series of activities geared towards accelerating development and improvement in the standard of living of the target group who are mostly the rural dwellers. In other words,

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026355

extension services refer to the aggregate of all services provided by extension agents for the purpose of promoting social, economic, political, and cultural wellbeing of the clienteles. Although extension services are mostly associated with agriculture, it covers wide range of activities that include agricultural production, home economics, family health and nutrition, population education, community development activities, among others. The numerous activities involve in extension services are complementary and interactive, each contributing to the success of accelerating development and improvement in the standard of living of the people. The dynamics and broadness of extension services call for need to ensure sustainable and continuous professional development for extension agents in order to arrest challenges associated with low professional competence and promote their productivity. Productivity of individuals is a product of many factors ranging from the training process, supervision and performance appraisal patterns, motivation and rewarding systems, and learning opportunities that are available. Vijayaragavan (2021) observes that organisations responsible for provision of extension services in developing countries face the major problems of professional incompetence and lack of motivation among their employees. Problem of professional incompetence is rooted in the quality of pre-service and post-service training programmes available to extension agents. While pre-service training are obtained in formal education settings like colleges, universities, etc., post-service training are usually received on the job through non-formal education settings like workshops, seminars, etc. planned to fill a skill-gap and improve upon the pre-service training (Nzeribe, 2011). This shows that continuous learning is pivotal to promotion of professional competence and improvement of productivities of extension agents. Hence, this paper examines the role of e-learning tools in enhancing productivity of extension agents in Nigeria.

Theoretical Framework

This paper is hinged on the Human Capital Theory (HCT) which views investment in education as a productive investment involving integration of human development into the economic development policies to enhance productive capacities of individuals, economic growth and national development. The development of HCT was propelled by the works of Theodore, W. Schultz in 1961 and Gary, S. Becker in 1964, who postulated that investment in education is akin to investment in human capital rather than mere social consumption (Ross, 2025). The term human capital refers to the personal qualities that are beneficial to improved productivity. Therefore, provision of continuous learning opportunities to extension agents will enhance their effectiveness and contributes to broader development outcomes (Swanson & Rajalahti, 2010). Such investment transcends beyond just social investment for human consumption; it is an economic investment that improves productivity, enhances career progression, and economic development. The focus of HCT is the need to enhance productivity, boost earning potentials, and overall economic growth through acquisition of knowledge, skills, and competencies. This was corroborated by Deming (2022) submission that education, training, and other forms of learning are capital investments whose costs are paid up-front and the benefits are earned later in the future. Within the context of extension services, extension agents represent an important category of human capital whose productivity significantly influences the effectiveness of extension programmes. Their ability to deliver relevant information, facilitate behavioural change, and promote community development initiatives largely depends on their level of knowledge, skills, and professional competence (Psacharopoulos & Patrinos, 2018; Swanson & Rajalahti, 2010). Continuous professional development therefore becomes an essential investment in human capital within extension systems. Training programmes, workshops, and educational opportunities serve as mechanisms for enhancing the knowledge base and technical capabilities of extension agents. The integration of e-learning platforms into extension training

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026355

systems can be understood as a strategic investment in human capital development. By providing flexible and accessible learning opportunities, e-learning enables extension agents to continuously upgrade their knowledge and skills, thereby improve their productivity and professional performance. Applying this theoretical perspective to extension services suggests that strengthening the capacity of extension agents through e-learning tools would significantly enhance the effectiveness of extension systems and efficiency of extension agents.

The Extension Agents

Extension agents are professionally trained development practitioners employed by governmental or non-governmental extension systems to facilitate the transfer of knowledge, innovations, and advisory services to defined client groups or communities. They function as critical intermediaries linking research institutions, policy systems, and local populations, translating scientific knowledge into practical and context-specific solutions that enhance productivity and social wellbeing (Alabi, et al, 2021; Jones & Garforth, 1997). Given the educational and participatory nature of extension work, extension agents operate within multiple and often competing role expectations covering educators, communicators, facilitators, change agents, and community mobilisers. Effective performance in these roles, according to Alabi, et al (2021) and Chiagorom eta al (2023), requires acquisition of multidisciplinary competence base training to facilitate technical expertise in the sector of operation, communication proficiency, adult education principles, group facilitation skills, and problem-diagnosis capabilities to extension agents. This echoed the centrality of extension agents as critical actors whose effectiveness success of extension programmes hinged. As a critical determinant of extension programme success or failure, continuous professional training and capacity development thus become essentials in enhancing extension agents' competencies in information dissemination, collective learning facilitation, and sustainable behavioural and technological change among target populations (Oladele & Tekana, 2010). Therefore, extension agents must possess good attributes that will be of positive values to attainment of extension programme objectives. Adebayo (2018) identifies the following as essential qualities which extension agents must possess:

Commitment: Good extension agents must be committed to extension work. They must be prepared and ready to work in isolated rural areas, with high sense of dedication and determination of introducing, monitoring and implementing extension programmes.

Reliability: Good extension agents must be trustworthy that the target group will have confidence in their advice and support. They must also be someone whose agency or superior officers can rely on their ability and competence to discharge their responsibilities without close supervision.

Humility: Good extension agents must be sensitive, understand and appreciate the socio-cultural diversity of the target group. They must also be sensitive to the wishes and feelings of the target group and respect them as people who have meaningful knowledge and ideas to contribute to achieve success.

Confidence: Good extension agents must believe in their own abilities and determination to achieve set objectives. They must be able to work in isolation without supervision.

Competence: Good extension agents must understand the technical subject they wish to extend and demonstrate competence in the required technical and practical skills needed for executing the extension programme.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026355

Eloquence: Good extension agents must be proficient public speakers. The principal task of extension agents is communication; this inevitably involves public speaking to explain ideas, conduct demonstrations or take part in discussion.

The essential characteristics expected of extension agents are testaments of the centrality of extension agents to success of extension services. As people with multiple roles and expectations, they are expected to perform the following functions:

Functions of Extension Agents

Change agent: As change agents, they are expected to help get the target group into a frame of mind, attitude and behaviour conducive for acceptance of changes. As change agents, they are expected to set a process of change in motion after realising and convince that such changes are necessary for the society.

Educator/facilitator: As educators or facilitators, extension agents engage in transfer of knowledge, skills and information that will enable the target group to understand and make rational decisions that will improve their productivity and standard of living. In doing this, extension agents find out which skills or areas of knowledge are lacking or needed by the target group and then arrange suitable learning experiences through which the clientele can acquire them.

Disseminator of information: Extension agents disseminate to their clientele results of research and also carry feedback from the clientele to research organisations. Extension agents being in contact with the target group can help research workers to understand problems and challenges of the target group so that appropriate solution can be provided.

Administrators and inculcate administrative skills: A successful change from subsistence production to commercial production requires good administrative acumen. Extension agents do not only exhibit administrative shrewdness but also inculcate it to the target group.

Intermediary between stakeholders: Extension agents serve as link between all stakeholders in extension services. There are many groups of people involve in extension. These include government ministries, research organisations, field workers and the target group. Extension agents serve as linkage between all these stakeholders in extension services.

Considering the expectations and functions extension agents are expected to efficiently perform towards accelerating development and improvement in the standard of living of the people, it becomes imperative to devise sustainable means for continuous facilitation of improvement in their productivity. Because there is no individual knowledgeable or competent beyond the need for improvement as underscore by the truism that “you start dying the moment you stop learning” (Adebayo, 2022). Therefore, there is need for flexible and wide learning opportunities that will enable extension agents expand horizon of their knowledge. To this end, there is need to explore and exploit opportunities provided by the development of information and communication technology (ICT) powered e-learning.

E-Learning

E-learning represents one of the most significant technological innovations in contemporary education and professional training systems. The concept broadly refers to the utilisation of electronic technologies and digital platforms to facilitate teaching, learning, and knowledge dissemination. Unlike conventional face-to-face learning systems, e-learning enables individuals to access educational resources through digital devices and internet-enabled platforms irrespective of geographical and temporal constraints. Consequently, e-learning has become an increasingly influential factor in learning and improvement of professional competence. Because access to

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026355

information is central to success of any learning activity, it expands access unlimited range of learning materials and learning platforms. E-learning also known as digital learning or online learning simply denotes learning conducted via electronic media, through the use of internet. E-learning is a fantastic way to expand horizons of knowledge, learn new skills and access learning materials anywhere, anytime. Shuaibu and Ahmed (2021) describe e-learning as a unifying term for online learning, web-based training and technology-based training. In other words, e-learning may be defined as the convergence of internet enabled learning. It is the use of network technologies to create, foster, deliver and facilitate learning anywhere and anytime. The delivery of individualises, comprehensive, dynamic learning content in real time aiding the development of communities of mastery, linking learners and practitioners with experts. Moore and Kearsley (2012) describe e-learning as instructional processes that are delivered through electronic technologies, particularly internet-based platforms, to support learning activities outside the traditional classroom environment. Similarly, Clark and Mayer (2016) define e-learning as instruction delivered via digital devices designed to support learning through multimedia content such as text, audio, video, animations, and interactive activities. As a rapidly evolving phenomenon, e-learning facilitates effective knowledge delivery, promotes accessibility, and offers opportunities for learners and organisations to adapt to the continuous innovations and accelerated changes characteristic of the internet-driven world. It is a force that gives people and organisations the completive edge to allow them to keep ahead of the rapidly changing global economy (Alharthi, & Plunkett, 2019; Shuaibu & Ahmed, 2021). The idea behind electronic learning is to empower learners to study without being confined to the four walls of classrooms or schools. As integration of learning with technology, e-learning are of different types.

Types of E-learning

The conglomerations of methods through which e-learning can be delivered can be grossly classified into two: synchronous methods also known as interactive methods and asynchronous methods also known as static methods.

Synchronous methods (Interactive methods): These are instructor-facilitated Web-based learning and it requires all the participants to be present, albeit virtually, at the same time. Examples of synchronous e-learning methods include the use of scheduled and timed online tests, virtual classrooms, web conferencing technology or interactive shared whiteboards like Skype and Zoom that learners can use to collaborate (Lutkevich, 2020).

Asynchronous methods (Static methods): These are self-directed and self-paced methods which enable participants to learn individually at their own pace and time through CD-ROM-based, network-based, intranet-based and internet-based. Examples of static methods include the use of learning portals, hyperlinked pages, streaming audio/video and digital materials like PDF documents, slideshows and word documents (Lutkevich, 2020). Asynchronous methods give learner freedom to choose the pace at which they consume the learning materials.

Irrespective of the methods, e-learning has revolutionised the educational system and expanded scope of options of instructional delivery strategies. It has offered new possibilities to inform, stimulate attention and actively involve learners in the learning processes to improve their knowledge, skills and performance. The importance of e-learning in promoting diverse and accessible learning opportunities cannot be overemphasised. The versatility of e-learning can be adapted to suit the divergent educational needs, learning styles and instructional methodologies of individuals. With this, it would therefore prove helpful to exploit accessibility of e-learning to facilitate improvement in productivity of extension agents.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026355

Importance of E-Learning in Enhancing Productivity of Extension Agents

E-learning will play significant importance towards facilitation of improvement in the productivity of extension agents in Nigeria. Internet has become a first port of call for many motivated learners and extension agents need to take advantages of easy access to availability of large information on internet to acquaint themselves with new discovery and development in extension services. This will enable them acquire knowledge and skills that will translate to improvement in their professional competence and productivity. E-learning has been recognised as an effective means of expanding affordable learning opportunities for individual and national development. To this end, extension agents should maximise opportunities provided by e-learning to access varied learning materials wherever they are at any time. This provides opportunities for extension agents to acquire functional relevant knowledge based on needs. This will promote development of individuals' unique natural endowment and their ability to contribute to development of their clienteles and the clienteles' communities.

The uniqueness of e-learning is rooted in the use of multimedia devices to continuous bridged the gap of space and time that exist between the learners and the teacher. This is done through a wide spectrum of technologies, such as: videotaped lectures, the internet, the compressed video, teleconferencing, video conferencing, computer conferencing, among others. Thus, e-learning promotes lifelong learning and improvement in productivity of extension agents. Furthermore, e-learning provides opportunities for extension agents to develop a self-paced training schedule. The learners-oriented system of e-learning allows flexibility in learning. This will enable extension agents to overcome impairment to continuous educational pursuit imposed by the constraints of time and demands of extension services. Moreover, the scalability of learning content and duration can be reasonably measured (Vijayaragavan, 2021). This will be beneficial to those extension agents who feel nervous and uncomfortable learning in groups by enabling them to learn without leaving the comforts of their homes and thereby promote higher degree of coverage and consistency in learning. Although, e-learning has become indispensable part of the mainstream educational system by bringing learners, tutors, and other interest groups together, some challenges may limit its utilisation for facilitating improvement in productivity of extension agents.

Challenges of E-Learning to Facilitating Improvement in Productivity of Extension Agents

Despite the benefits of e-learning to facilitation of productivity of extension agents in Nigeria, some challenges are undermining its utilisation. These challenges include:

Low proficiency in ICT usage: Learning via e-learning requires learners to be proficient in usage of ICT devices and software applications such as computer, internet, Zoom, Skype, etc. According to Isuji (2010) 45.80% of learners in Open and Distance Education in Nigeria lack computer literacy skills. Acquisition of proficiency in the usage of ICT and software applications comes with a cost. Other problems militating against the usage of ICT facilities to facilitation of productivity of extension agents in Nigeria are high cost of ICT gadgets and services, poor internet access, low internet bandwidth, irregular power supply and absence of alternative source of power especially in the rural areas. While it is easy for learners facing technical issues in a physical class to access help from the IT department and experts, learners in online classes have to try to find solution by themselves.

Inadequate interaction and engagement: Considering the fact that extension activities are directed mostly to people in rural areas, extension agents are more likely to work individually in remote areas. It is difficult for extension agents to interact with and adequately get to know each other. This is because interaction via Zoom, Google Meet or Skype is not the same as physical

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026355

interaction. According to Burton (2022), the absence of course mates and teachers in the immediate learning environment can cause learners to feel isolated and disconnected from the class and make them not to engage the way they would have engage in a physical setting. Consequently, attendance, participation and academic performance may decline and this would negatively impact on their professional performance.

Inadequate availability of relevance learning materials: Learning materials are the totality of information carrying devices that are used to ease, encourage, improve and promote learning activities. Despite that learning materials exist in prints, visual, audio and audio-visual forms, accessing relevant learning materials suitable to promote productivity of extension agents remains a challenge. E-learning materials for extension agents should not be a one-size fits all (Shanahan, 2023) because different extension agents working in different fields have varied knowledge and skill-gap needs. Regrettably, the materials needed by extension agents to bridge professional knowledge and skill-gap needs for improve productivity are always not adequately available and accessible.

Less practical training: E-learning mostly provides provide learners with the theoretical aspect of a training exercise while little provision is made available for practical training. Considering the fact that extension activities are mostly practical oriented in nature, it becomes difficult for extension agents to acquire the needed practical knowledge and skills needed for professional efficiency thorough e-learning. Therefore, there is need for integration of traditional face-to-face training into e-learning.

Conclusion

Overcoming challenges associated with utilisation of e-learning instructional facilities by extension agents is paramount to stimulate improvement in professional competence and productivity of extension agents as well as to accelerate development and improvement in the standard of living of the beneficiaries of extension services who are mostly the rural dwellers. Hence, recommendations offer by this paper should be systematically implemented.

Recommendations

1. To overcome the challenges associated with low proficiency in ICT, there is need to employ people who are computer literates and those who are willing to acquire more proficiency in computer utilisation as extension agents. In addition, regular periodic training in computer applications should always by organised for extension agents. This will enable the extension agents to be conversant with latest development in ICT and versatile with usage of different ICT gadgets.
2. To overcome the challenges associated with inadequate interaction and engagement, there is need to infuse opportunities for social networking and interaction in e-learning programmes designed for extension agents. This can be done by incorporating group discussion and interactive session into the learning process.
3. To overcome the challenges associated with inadequate availability of relevance learning materials, there is need for extension organisations to subscribe with learning institutions and research data base all over the world in order to access learning materials from them. Subscribing to the data base of some learning institutions and research organisations require payment and most extension agents may not be able to afford the payments.
4. To overcome the challenges associated with low practical training, there is need for extension organisations to always collaborate with extension training institutions to provide opportunities to put what is leant into practice. Practical sessions cab be organised on a geo-political zone or region or state basis for extension agents with provision made for their transportation, accommodation and feeding allowances.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026355

References

Adebayo, M. (2018). ANF 114: Extension education. Unpublished lecture reading material for Adult and Non-Formal Education students, FUE, Zaria

Adebayo, M. (2022). Continuing education, teachers' improvement and national development: The tripod. *Ilmi Multi-Disciplinary Journal of Education 3(1),* 231-237

Alabi, O. S., Ajayi, A. O., Fapojuwo, O. E., & Alabi, T. O. (2021). Knowledge and skill of agricultural extension agents in research and data management in Southwest Nigeria. *Ife Journal of Agriculture, 33*(3). 10-19

Alharthi, H., & Plunkett, M. (2019). E-learning adoption and implementation: Factors and challenges. *Journal of Information Technology Education: Research, 18(1),* 57–83.

Burton, C. (2022). 7 top challenges with online learning for students (and solutions) Access on https://www.thinkific.com/blog/challenges-with-online-learning/

Chiagorom, V. C., Osuchukwu, L. C., Nzereogu, I. K., & Akojuru, A. T. (2023). The role of agricultural extension services in Nigeria. *ASRIC Journal of Agricultural Sciences.* 155-158

Jones, G. E., & Garforth, C. (1997). *Improving agricultural extension: A reference manual.* FAO.

Lutkevich, B. (2020). E-learning (online learning). Retrieved 22 May, 2023 from https://www.techtarget.com/whatis/definition/Web-based-training-e-learning

National Open University of Nigeria. (2023). *Agricultural extension and rural development course material.*

Nzeribe, T.A.K. (2011). Critical challenges of pre and post service extension education and training in Nigeria. *Journal of Agricultural Extension, 15(1),* 93-98 http://dx.doi.org/10.4314/jae.v15i1.10

Oladele, O. I., & Tekana, S. S. (2010). Determinants of extension agents' competencies in dissemination of agricultural innovations. *Journal of Human Ecology, 30*(1), 1–6. https://doi.org/10.1080/09709274.2010.11906262

Osuji, U.S.A. (2010). An assessment of the computer literacy level of Open and Distance Learning students in Lagos state, Nigeria. *Turkish Online Journal of Distance Education-TOJDE,* 11(4), 149-158 ISSN 1302-6488

Psacharopoulos, G., & Patrinos, H. A. (2018). Returns to investment in education: A decennial review of the global literature. *Education Economics, 26*(5), 445–458.

Shanahan, A. (2023). The top 10 e-learning challenges L&D professionals face every day. Accessed at https://www.docebo.com/learning-net/blog/elearning-challenges

Shuaibu, A. and Ahmad, M. A. (2021). The need for improved e-learning programme for effective secondary school curriculum delivery in time of insecurity in Nigeria. *Journal of Special, Adult and Non-Formal Education (JOSANFE)* 1(1), 190-195

Swanson, B. E., & Rajalahti, R. (2010). *Strengthening agricultural extension and advisory systems: Procedures for assessing, transforming, and evaluating extension systems*. World Bank.

Vijayaragavan, K. (2021). Managing human resources within extension. Accessed at https://www.fao.org/3/W5830E/w5830e0g.htm

Yakubu D.H., Douseifa G.G.B., Ango A.K., and Alhassan J. (2025). Socioeconomic determinants of agricultural extension needs among yam farmers in Nasarawa State, Nigeria. *Journal of Agricultural Extension,* 29(1), 126-132

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026356

Assessment of Deposit Money Banks Credit, Banking Sector Depth and Economic Growth in Nigeria: An Econometric Investigation 1987-2024

NZOGBU, Ugochukwu I.[1]
Email: elgopen@yahoo.co.uk
elgopeny.u.i@gmail.com
08068575248

TSENKWO, Joseph B.[1]
Email: tsenkwoj@gmail.com
07035256816

GOSHIT, Gideon G.[1]
Email: goshite@unijos.edu.ng
08036055243

[1]Department of Economics, University of Jos, Plateau State, Nigeria

Abstract

This study investigates how deposit money banks' credit and the banking sector's depth affect Nigeria's economic growth. Despite reforms, Nigeria struggles to turn financial expansion into sustained economic growth. Using a causal design and the ARDL model, the study finds significant short- and long-term effects of banking sector depth proxies on GDP. Results show banking sector's financial depth boosts growth; deposit money banks' credit and deposit liabilities positively impact GDP, highlighting banking's role in mobilising deposits and credit. However, the negative private credit-to-GDP ratio suggests private credit is directed to less productive sectors. The study recommends focusing on productive sector credit, improving financial inclusion, optimising interest rates, and strengthening banking stability. Effective reforms and robust financial intermediation are essential for Nigeria's sustainable growth.

Keywords: Deposit money banks' credit, banking sector depth, Economic Growth (GDP)

Introduction

Economic growth depends on a strong financial system and the effectiveness of deposit money banks (DMBs) in allocating credit. Studies link banking sector depth to growth, highlighting the importance of credit distribution for development. Models like the supply-leading hypothesis, the economic theory of bank credit, and the quantity theory of credit emphasise bank credit's role in growth. Financial liberalisation suggests deeper systems boost economic expansion, especially in developing countries. DMBs promote innovation (Schumpeter, 1911), create money (Hahn, 1930; Werner, 1992), and facilitate transactions (Werner, 2018). Liberalisation encourages banking depth, capital accumulation, and growth. Developed countries like the US, Germany, and Japan have extensive financial systems, with private credit exceeding 100% of GDP and M2 over 120%. Demand deposit liabilities to GDP are around 50-60%, for example, about 40-50% in the US and 130-140% in Japan, supporting growth. Some African nations, such as South Africa, Morocco, and Tunisia, have moderately developed systems, with private credit-to-GDP ratios from 60% to 100%. South Africa's demand deposits are 60-70%, Egypt's about 40-50%, aiding 3-4% annual growth. Nigeria's financial system is shallow, with private credit at 20%, M2 at 30%, demand deposits at 20-30%, and 2% growth. Opportunities exist to reform Nigeria's sector for higher growth (IMF, 2023; World Bank, 2023a). In developing countries, economic growth depends on financial system depth. Bank credit is crucial for investment, growth, innovation, and job creation. Banking sector depth shows how well savings are mobilised and used productively. Limited credit access, underdeveloped markets, and

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026356

weak institutions hinder these benefits. A deep financial system fosters growth by efficiently allocating credit and expanding markets, with bank credit boosting investment, innovation, and employment (Loveth, Felix, & Nkamere, 2025). Countries with high deposit-to-GDP ratios tend to mobilise more deposits for lending, boosting economic growth. Lower ratios, like Nigeria's 20-30%, suggest limited financial inclusion and credit, hindering growth. Despite DMBs' credit to the private sector rising from ₦21 billion in 1987 to ₦26,177 billion in 2024, the CPS to GDP ratio stays below the World Bank's 25% threshold (World Bank, 2018). This study examines how bank credit and banking sector depth influence Nigeria's economic growth, offering empirical evidence to reassure researchers and policymakers that data-driven decisions can promote sustainable economic growth and development.

Objectives of the Study

This study aims to investigate the impact of deposit money banks' credit and banking sector financial depth on Nigeria's economic growth. Specifically, the objectives are:

1. To examine the effect of deposit money banks' credit on economic growth in Nigeria.
2. To assess the influence of banking sector depth on economic growth in Nigeria.
3. To investigate the joint impact of deposit money banks' credit and banking sector depth on economic growth in Nigeria.

This research advances credit-depth-led growth literature, offering policy insights on credit management and the impact of banking sector depth on economic growth. Findings help policymakers make informed decisions, stressing the importance of capitalising deposit money banks (DMBs) for effective lending. Results also guide monetary and regulatory authorities on using credit expansion and banking sector depth for sustainable growth, considering macroeconomic stability and institutional factors.

Research Questions

1. What is the impact of deposit money banks' credit on Nigeria's economic growth?
2. How does banking sector depth, measured by private sector credit to GDP ratio, demand deposit liabilities to GDP ratio, and interest rate spread, influence Nigeria's economic growth?
3. What is the combined effect of deposit money banks' credit and the financial depth of the banking sector on Nigeria's economic growth?

Literature Review

The framework examines how the deposit money banks' credit and banking sector depth impacts Nigeria's economic growth, using indicators such as Private Sector Credit/GDP, demand deposit liabilities to GDP, and interest rate spread. It considers macroeconomic stability via the monetary policy rate as a mediator, with the loan-to-deposit ratio controlling for banks' intermediation in growth. The study cites the theory of Credit Rationing (Stiglitz & Weiss, 1981), which explains how information asymmetry causes credit rationing, limiting effective credit distribution. It also discusses the Financial Liberalisation Theory, noting that liberalisation does not always improve credit allocation due to information asymmetry, and mentions the quantity theory of credit, which describes how deposit money banks' credit impacts growth. Stiglitz and Weiss (1981) developed the credit rationing theory, showing that limited information causes credit restrictions. Information asymmetry hinders banks' lending. They argue that financial liberalisation does not always improve credit allocation because savings go into investments. Riskier borrowers accept higher rates, worsening adverse effects and moral hazard, leading to credit rationing where lenders cannot accurately assess risk. The Financial Liberalisation Theory (Shaw, 1973; McKinnon, 1973) claims that liberalising financial systems boosts growth in developing economies by enhancing efficiency, cutting costs, and

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026356

expanding credit access. It promotes savings and affordable borrowing, strengthening financial institutions. The theory assumes that a liberalised system effectively channels resources to productive sectors, driving economic growth. The Quantity Theory of Credit (QTC) (Werner, 1992; 1997) explains credit's role in economic growth, distinguishing between credit for real-sector activities and non-productive sectors. It emphasises banks' ability to create money and urges policymakers to focus on bank credit rather than the money supply, promoting credit flow into growth. sectors. It is a valuable framework for understanding economic expansion and growth. Research highlights the bank credit's role in economic growth, especially in developing economies. Studies (King & Levine, 1993; Beck et al., 2000; Adebisi & Ewa, 2020; Amos, 2020; Ajudua, 2023; Ornan & Miftahu, 2023; Khom, Omkar, Yadav & Pramshu, 2024; Onigah, 2024) link private-sector credit to growth and capital accumulation. However, weak institutions and poor regulation can limit the effectiveness of credit (Demetriades & Hussein, 1996). In sub-Saharan Africa, high non-performing loans and limited financial inclusion constrain credit impact (Odhiambo, 2008). Credit's effectiveness depends on institutional quality and macroeconomic stability. Banking sector depth, measured by private-sector credit and demand deposit liabilities to GDP, is linked to growth (Levine, 2005; Rajan & Zingales, 1998). Deeper systems improve resource allocation, reduce costs, and aid risk management. Results from developing economies are mixed, with shallow markets and weak institutions limiting benefits (Nguena & Nchofoung, 2020; Adenuga & Omotosho, 2020). In sub-Saharan Africa, financial depth supports growth but has a modest impact compared to developed regions (Al-Homaidi et al., 2020; Loveth, Felix, & Nkamere, 2025). Also, Ikhsan and Satrianto (2023) show that banking sector depth has a significant effect on economic growth, but it is dependent on financial market efficiency. Context matters; Banking sector depth drives growth, but its effectiveness depends on the institutional quality and macroeconomic environment.

Research Methodology

This study used a causal research design to examine variable relationships, integrating theoretical and empirical literature for insights (Kerlinger & Howard, 2013). It analysed annual data from 1987 to 2024 due to data availability. Key variables like GDP, deposits, interest rates, and ratios showed consistent trends, shocks, and correlations with past values. Data included real GDP, deposit credit, ratios, liabilities, interest spread, bank rate, and loan-to-deposit ratio from the Central Bank of Nigeria's bulletins.

Model Specification

Based on existing literature, the relationship among deposit money banks' credit, banking sector depth, and economic growth can be expressed as influenced by Werner (2018), Tursoy and Faisal (2018), and Le, Ho, and Vu (2019). This adapted framework for this study is expressed implicitly and functionally as follows:

GDP= f (DBCPS, IRS, BSFC, CBSP, BNKR, LTDR) . . . 1

Where: DBCPS is the deposit money bank credit, IRS is the interest rate spread, BSFC measures the banking system financing via private sector credit to GDP, CBSP indicates the deposit money bank contribution via demand deposits to GDP, BNKR is the monetary policy rate, and LTDR is the loan to deposit ratio. Introducing natural logs to equation (1) could improve estimation efficiency of parameters over the linear model; thus, equation (1) is expressed as:

$$lnGDP = \lambda_0 + \lambda_1 ln\, DBCPS + \lambda_2 IRS + \lambda_3 lnBSFC + \lambda_4 lnCBSP + \lambda_5 lnBNKR + \lambda_6 lnLTDR + \mu_t \quad \ldots 2$$

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026356

Where: GDP, DBCPS, IRS, BSFC, CBSP, BNKR, LTDR are as earlier specified, *ln* denotes natural logarithms,λ_0 is the intercept, $\lambda_1 - \lambda_7$ are coefficients of variables, and μ_t is a serially uncorrelated error term.

A priori, DMBs credit to the productive sector ($\lambda 1 > 0$), DMB/GDP ratio ($\lambda 3 > 0$), and demand deposit liabilities to GDP ($\lambda 4 > 0$) are expected to influence GDP positively. In contrast, the Interest Rate Spread ($\lambda 2 < 0$) likely impacts GDP negatively in developed countries but may increase it in developing countries. The Bank Rate ($\lambda 5$) has an uncertain effect, and the Loan-to-Deposit Ratio ($\lambda 6$) is expected to affect GDP positively. Overall, increases in DMBs credit to the productive sector, DMB/GDP ratio, and deposit liabilities to GDP should boost GDP, while a higher Interest Rate Spread likely reduces it. The effects of the Bank Rate and Loan-to-Deposit Ratio are uncertain. These expectations align with economic theories (Keynes, 1936; Shaw, 1973; Werner, 2018).

Estimation Technique

ARDL and UECM models were used since the variables were integrated at different orders (I(0) and I(1)). The ARDL specification of the model in equation (2) is:

$$\Delta lnGDP = \lambda_0 + \lambda_1 ln\ DBCPS_{t-1} + \lambda_2 lnCBSP_{t-1} + \lambda_3 lnBSFC_{t-1} + \lambda_4 lnIRS_{t-1} + \lambda_5\ lnBNKR_{t-1} \lambda_6 lnLTDR_{t-1} + \sum_{i=0}^{n} \mu_7\ \Delta ln\ DBCPS_{t-1} + \sum_{i=0}^{n} \mu_8 \Delta\ ln\ CBSP_{t-1} + \sum_{i=0}^{n} \mu_9 \Delta\ ln\ BSFC_{t-1} + \sum_{i=0}^{n} \mu_{10} \Delta\ ln\ IRS_{t-1} + \sum_{i=0}^{n} \mu_{11} \Delta\ ln\ BNKR_{t-1} + \sum_{i=0}^{n} \mu_{12}\ \Delta\ ln\ LTDR_{t-1} + \Omega ECM_{t-1} + \mu_t \quad \ldots 3$$

In equation (3), Δ is the change operator, n is the lag length, and μt is the error term. Ω is the adjustment speed, and ECM is the residual from equation (3). Ω is expected to be negative and statistically significant. The equation's long-run and short-run estimators are represented by the parts with and without the difference operator, respectively. The bound test checks for cointegration by testing the joint significance of $\lambda 1$-$\lambda 6$ using F-statistics. The null hypothesis (H0) is no cointegration ($\lambda 1 = \lambda 2 = \ldots = \lambda 6 = 0$), tested against the alternative hypothesis (H1: at least one $\lambda \neq 0$).

Presentation of Results

Descriptive Statistics Result

Table 1's descriptive statistics highlight variable characteristics. GDP has the highest mean (9.5060), while BSFC is the lowest (2.1462). Most means align with medians, indicating symmetry. EXR shows high variability (1.3427). Most variables are negatively skewed, especially IRS (-1.9626). IRS also has the highest kurtosis (6.6022), with GDP the lowest (1.9718). Jarque-Bera tests show IRS and BNKR deviate from normality ($p<0.05$). These stats reveal distribution traits and areas for further analysis, such as IRS's and BNKR non-normality.

Table 1: Result of VIF Test for Variables in Model

	GDP	DBCPS	IRS	BNKR	BSFC	CBSP	LTDR
Mean	9.506	7.0295	2.3504	2.5893	2.1462	2.4223	4.1619
Median	9.9268	7.4576	2.5618	2.6027	2.1776	2.4509	4.1684
Maximum	12.2178	10.1065	3.0301	3.2581	2.8252	3.1066	4.5729
Minimum	5.5	2.7594	0.5068	1.7918	1.4223	1.6306	3.6259
Std. Dev.	2.0644	2.4081	0.5544	0.2822	0.383	0.3715	0.2132
Skewness	-0.4756	-0.44	-1.9626	-0.6777	-0.1915	-0.1891	-0.5698
Kurtosis	1.9718	1.7871	6.6022	4.8231	2.0646	2.5648	3.0865
Jarque-Bera	2.9428	3.3686	42.5747	7.7416	1.5324	0.4987	1.9591
Probability	0.2296	0.1856	0	0.0208	0.4648	0.7793	0.3755
Sum	342.216	253.064	84.6139	93.2164	77.2629	87.2042	149.829
Sum Sq.Dev	149.167	202.965	10.7569	2.7879	5.133	4.8298	1.5906

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026356

Observations	36	36	36	36	36	36	36

Source: Eviews 10.0

Multicollinearity Test

The VIF results in Table 2 indicate no severe multicollinearity, with all values below 10. The average VIF of 3.0617 suggests moderate correlation among independent variables, which is acceptable for reliable analysis.

Table 2: Multicollinearity Test Result (Variance Inflation Factor)

Variable	Coefficient variance	Centered VIF
DBCPS	0.001	4.6914
BSFC	0.0449	5.6538
CBSP	0.0256	3.0595
BNKR	0.0229	1.5881
IRS	0.0081	1.9285
LTDR	0.0369	1.4489
Mean of VIF	0.0232	3.0617

Source: Eviews

Unit Root Test Result

The Vogelsang-Perron unit root test with a breakpoint confirms mixed integration, matching the ADF results. GDP, IRS, and LTDR are I(0), while DBCPS, CDSP, BSFC, BNKR, and EXR are I(1) and effectively capture gradual shifts in the series's mean.

Table 3: Results of Vogelsang and Perron Unit Root Test With Break Point (Innovation Outliers)

	At Level				At First Difference				
Variables	Test Statistics	Critical value@ 5%	Prob. Value	Break Date	Test Statistics	Critical Value@ 5%	Prob. Value	Break Date	Decision
GDP	-5.426	-4.4437	0.01*	1991	-5.685	-4.4437	0.01*	1995	I (0)
DBCPS	-2.827	-4.4437	0.774	1992	-6.816	-4.4437	0.01*	2007	I (1)
CBSP	-3.69	-4.4437	0.288	2005	-5.537	-4.4437	0.01*	1995	I (1)
BSFC	-3.792	-4.4437	0.24	2000	-7.837	-4.4437	0.01*	1997	I (1)
BNKR	-3.658	-4.4437	0.303	1993	-7.895	-4.4437	0.01*	2011	I (1)
EXR	-4.363	-4.4437	0.063	1998	-9.939	-4.4437	0.01*	1999	I (1)
IRS	-6.741	-4.4437	0.01*	1997	-14.56	-4.4437	0.01*	1993	I (0)
LTDR	-5.773	-4.4437	0.01*	2009	-5.739	-4.4437	0.01*	2010	I (0)

Source: Eviews 10.0

The Vogelsang-Perron test shows GDP, IRS, and LTDR are level I(0), while DBCPS, CBSP, BSFC, BNKR, and EXR are first differences I(1). Break points indicate structural changes and are linked to policy reforms: CBSP (1995), IRS (1997), EXR (1999), DBCPS (2007), BNKR (2011), with some breaks

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026356

for GDP, BSFC, and LTDR in various years. The ARDL estimation used this test, and the Quandt-Andrews test found no structural breaks in the model's variables.

ARDL Bounds (Cointegration) Test

The ARDL bounds cointegration test from Table 4 confirms cointegration since the F-statistic exceeds the upper bound critical value at 5%, indicating a significant long-term relationship and rejecting the null of no level relationship.

Table 4: ARDL Bounds Test Result

Estimated Model	Optimal Lag	F- Stat	Is there cointegration
ln GDPt = f (lnDBCPS, lnCBSP, lnBSFC, lnIRS, lnBNKR, lnLTDR)	2,3,3, 3, 2, 3,3	3.6865**	YES
	Lower Bound	Upper Bound	
Critical Values	I (0)	I (1)	
1%	2.88	3.99	
5%	2.27	3.28	
10%	2.88	2.94	

Source: Eviews 10.0

Note: The Akaike Information Criteria (AIC) was used to select the optimal lag for each cointegration model. I (0) and I (1) denote lower and upper bounds of the ARDL.

ARDL RESULT

Long-run estimates from Table 5 show that DBCPS, BSFC, CBSP, and IRS are significant at 5%. DBCPS positively influences growth, while BSFC has a negative impact. In the short term, GDP, IRS, and LTDR (1-year lag) are significant. Additionally, DBCPS, CBSP, BNKR (lags 1 and 2), and BSFC (lag 2) are also statistically significant. Deposit Money Banks Credit to Productive Sector (DBCPS) positively influences Nigeria's GDP (0.7344, $p<0.05$), supporting the idea that credit drives growth, as Schumpeter and Werner noted. Private Sector Credit to GDP (BSFC) negatively impacts (-0.7600, $p<0.05$), suggesting unproductive credit may harm growth, per Arcand et al. (2015). Demand Deposit Liabilities to GDP (CBSP) positively affect growth (0.0569, $p<0.05$), indicating financial intermediation supports growth. The Interest Rate Spread (IRS) also positively impacts (0.0604, $p<0.05$), possibly reflecting efficient lending or high risk. Loan-to-Deposit Ratio (LTDR) and Monetary Policy Rate (BNKR) lack significant long-term effects.

Table 5: ARDL Result

Dependent variable=*ln GDP* (2, 3, 3, 3, 2, 3, 3)

Variable	Coefficient	Std. Error	t-Statistic	P-Value
LONG-RUN ESTIMATES				
ln DBCPS	0.7344	0.0391	18.7795	0.0000**
ln BSFC	-0.76	0.03	-25.322	0.0000**
ln CBSP	0.0569	0.0257	2.2161	0.0342**
ln IRS	0.0604	0.0091	6.6492	0.0003**
ln LTDR	-0.0474	0.027	-1.7536	0.1229
ln BNKR	0.0032	0.0155	0.2088	0.8405
SHORT-RUN ESTIMATES				
Δ ln GDP (-1)	0.4618	0.093	4.9678	0.0016**
Δ ln DBCPS (-1)	-0.2881	0.0813	-3.5454	0.0094**
Δ ln DBCPS (-2)	0.1836	0.0362	5.0723	0.0014**
Δ ln BSFC (-1)	0.0371	0.0668	0.5555	0.5959

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026356

Δ ln BSFC (-2)	-0.3517	0.0452	-7.7892	0.0001**
Δ ln CBSP (-1)	0.1781	0.0333	5.3392	0.0011**
Δ ln CBSP (-2)	0.1485	0.0221	6.7142	0.0003**
Δ ln IRS (-1)	0.0896	0.0103	8.6957	0.0001**
Δ ln LTDR (-1)	0.0743	0.0208	3.5728	0.0091**
Δ ln LTDR (-2)	0.0229	0.0177	1.2913	0.2376
Δ ln BNKR (-1)	-0.1139	0.0187	-6.0786	0.0005**
Δ ln BNKR (-2)	-0.0882	0.0142	-6.2116	0.0004**
ECM (-1)	-0.6103	0.0795	-7.6802	0.0001**

R-squared value is 0.99246, the Adjusted R-squared is 0.98276, the Standard Error of the regression is 0.01519, the Akaike Information Criterion is -5.2417, the Schwarz Criterion is -4.3801, and the Hannan-Quinn Criterion is 4.9518. The F-statistic is 8933.12, as sourced from EViews 10.0. Diagnostic assessments in Table 6 confirm the model's reliability: no evidence of serial correlation or heteroscedasticity per Breusch-Godfrey and ARCH tests ($p > 0.05$). Variables are normally distributed, confirmed by Jacque-Bera ($p > 0.05$). Models are well-specified, as shown by Ramsay Reset ($p < 0.05$), and the error terms are white noise, making estimates efficient and reliable.

Table 6: Residual Diagnostic Result for Model

Test statistics	F-Statistics	P-Value
Normality (λ_2 -JARQUE- BERA)	1.0906	0.5797
Serial Correlation (λ_2 -BREUSCH-GODFREY)	0.0285	0.8715
Heteroscedasticity (λ_2 -ARCH)	0.0335	0.8559
Ramsey Reset (λ_2 -RESET)	3.5903	0.1069

Source: Eviews

The Stability tests (CUSUM and CUSUMSQ) in Figures 1 and 2 show that the residuals are within 5% critical bounds. Therefore, the ARDL models for the study are stable, efficient, and reliable.

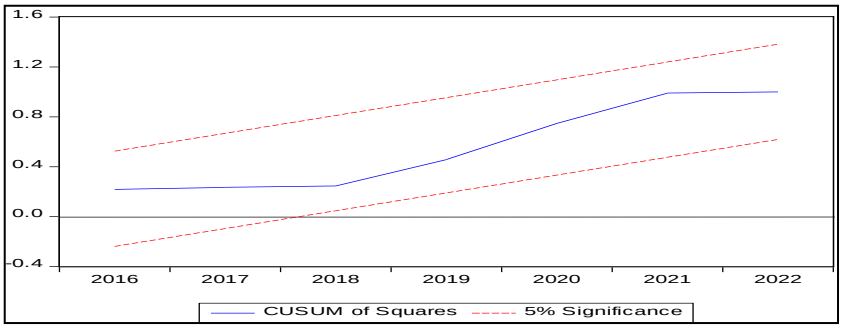


Figure 1 shows CUSUM

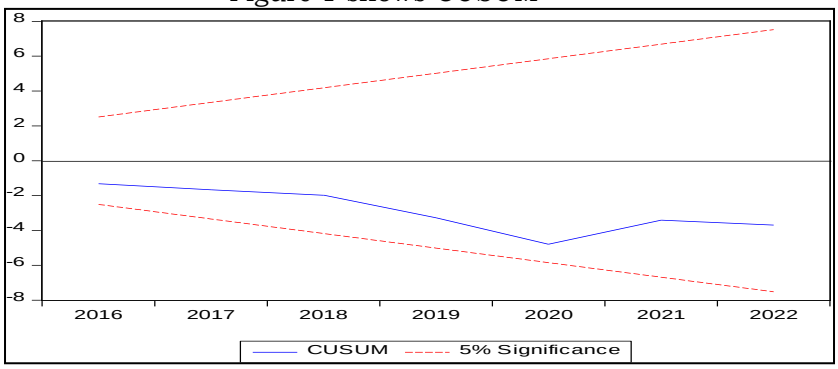


Figure 2 shows the CUSUM of Squares.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026356

Discussion of Findings

Deposit money banks' credit (DBCPS) and interest rate spread (IRS) positively influence Nigeria's economic growth, supporting financial intermediation by mobilising deposits and extending credit. The interest rate spread's (IRS) positive effect suggests banks' profitability may drive credit supply, boosting growth. The monetary policy rate (BNKR) has a positive but insignificant impact on GDP, indicating weak or indirect effects, possibly due to transmission issues like rate pass-through problems. The loan-to-deposit ratio's (LTDR) insignificant positive effect means lending is not solely based on deposits. Conversely, the negative, significant credit-to-GDP (BSFC) ratio suggests increased private-sector credit may reduce GDP growth, possibly due to credit flowing into less productive sectors, distressed borrowing, unproductive investments, or crowding out public investments. In the short term, all variables, Deposit Money Banks' Credit (DBCPS), Demand Deposit Liabilities to GDP (CBSP), Private Sector Credit to GDP (BSFC), Monetary Policy Rate (BNKR), and Loan-to-Deposit Ratio (LTDR) significantly impacted GDP, showing banking sector influence on Nigeria's short-term growth. Long-term results diverged, with BNKR and LTDR seen as insignificant, indicating short-term growth is more affected by financial sector fluctuations. The lack of effects from lagged interest rates and the two-year lag of LTDR suggest these influences are transient or rapidly adjusted. This implies policy effects take time to influence growth or are offset by other factors, highlighting the importance of short-term dynamics. This study's findings imply that promoting deposit mobilisation and credit, especially to productive sectors, can foster growth. The negative impact indicates a need to direct private credit away from less productive or speculative activities. The limited effect of monetary policy rates suggests reviewing credit market channels and banking challenges. The insignificance of the loan-to-deposit ratio may imply that banks' lending depends on other factors like risk appetite and sector preferences.

Conclusion

This study shows that deposit money banks' credit, demand deposit liabilities to GDP, and interest rate spread significantly drive Nigeria's economic growth, emphasising the banking system's role and depth. Policies fostering banking sector depth and efficient credit can boost growth. The study also finds banking sector depth variables like bank demand deposits to GDP ratio, private sector credit GDP ratio, the monetary policy rate, and the loan-to-deposit ratio have short-term effects, with sustained long-term influence of bank credit, demand deposits, and the interest rate spread on economic growth and development.

Policy Recommendations

1. CBN and Deposit money banks should prioritise credit to the real sector, expand financial inclusion, increase banking access, and improve financial literacy to boost savings and demand deposits.
2. They should also promote competition to optimise interest rate profitability with affordable credit.
3. CBN should strengthen banking stability by implementing reforms, ensuring efficient financial intermediation, and risk management.
4. The Federal Government, through the CBN, should monitor macroeconomic stability to support banking sector performance through targeted interventions (such as granting low-interest loans for priority sectors).

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026356

References

Adebisi, A., & Ewa, U. (2020). Deposit money, banks' services, and economic growth in Nigeria. *International journal of finance and accounting,* 9(2), 31–41.

Ajudua, E., I. (2023). Deposit money, banks, credit, and the Nigerian economic growth: An empirical analysis. *Economic Insights: Trends and Challenges,* 12(2), 1–10.

Amos, N. S. (2020). Deposit money, banks, credit, and economic growth in Nigeria. *Lafia Journal of economics and management sciences*, 5(1), 8–26.

Arcand, J. L., B. E., & Panzza, U. (2015). Too much finance? *Journal of Economic Growth,* 20 (2)105-148

Al-Homaidi, E. A., Tabash, M. I., Khan, S., & Taufiq, M. (2020). Bank profitability, stability, and liquidity: Evidence from an emerging economy. *Journal of Financial Economics Policy, 2*(2), 237–258.

Beck, T., Demirgüç-Kunt, A., & Levine, R. (2000). A new database on financial development and structure. *World Bank Economic Review,* 14(3), 597–605.

Demetriades, P. O., & Hussein, K. A. (1996). Does financial development cause economic growth? Time-series evidence from 16 countries. *Journal of Development Economics,* 51(2), 387–411.

Hahn, L. A. (1930). Economic theory of bank credit. *Oxford* revised ed., 147–149.

Ikhsan, A., & Satrianto, A. (2023). The effect of financial development on economic growth in higher income countries. *Asian economic and financial review*, 13 (3), 202–215

International Monetary Fund (IMF). (2023). *International Financial Statistics (IFS)*

Keynes, J. M. (1936). *The general theory of employment, interest, and money*. London: Macmillan, Cambridge University Press.

Kerlinger, F. N., & Howard, B. L. (2013). *Foundations of behavioural research* (4th Ed.)Belmont, CA: Wadsworth.

Khom, R. K., Omkar, P., Yadav, M. U., & Pramshu, N. (2024). Effect of private sector credit on economic growth in Nepal. *Financial markets, institutions and risks*, 8(1), 142-157.

King, R. G., & Levine, R. (1993). Finance and growth: Schumpeter might be right. Quarterly *Journal of Economics,* 108(3), 717–737.

Le, Q., Hoa, H., & Vu, T. (2019). Financial depth and economic growth: empirical evidence from ASEAN+3 countries. *Management Science Letters*, 9(6), 851–864.

Levine, R. (2005). Finance and growth: Theory and evidence. Handbook of Economic Growth, 1, 865–934.

Loveth, O., Felix, N. E., & Nkamere, S. E. (2025).Effect of financial development on economic growth in Nigeria: 1984 -2024.*International Journal of finance, Accounting and Management science,* 2 (1). 112-133.

McKinnon, R. I. (1973). *Money and Capital in Economic Development*. Washington, D.C: Brookings Institution.

Ngutua, J. E., & Nchofoung, T. N. (2020). Financial inclusion and economic growth in Cameroon. *Journal of Economics and Finance,* 44(3), 495–513.

Odhiambo, N. M. (2008). Financial development in Kenya: a dynamic test of the finance-led growth hypothesis. Savings and Development, 32(1), 57–74.

Onigah, P. O. (2024). Impact of banking sector credits on economic growth in Nigeria. *Journal of Management Sciences*, 60 (3), 12-51.

Ornan, W. Y., & Muftahu, I. (2023). Effect of banking credit on economic growth: Evidence from Nigeria. *International journal of economics and development policy-IJEDP*, 6(1), 117-134.

Rajan, R. G., & Zingales, L. (1998). Financial dependence and growth. *American Economic Review,* 88(3), 559–586.

Schumpeter, J. A. (1911). *The theory of economic development*. Cambridge, Massachusetts, Harvard University Press.

Shaw, E. S. (1973). *Financial deepening and economic development*. New York: Oxford University Press.

Stiglitz, J. E., & Weiss, A. (1981). Credit rationing in markets with imperfect information. *American Economic Review,* 71(3), 393-410.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026356

Türsoy, T., & Faisal, F. (2018). Does financial depth impact economic growth in North Cyprus? *Financial Innovation*, 4 (12), 1–13.

Werner, R. A. (1992). *Towards a quantity theorem of disaggregated credit and international capital flows* paper presented at the Royal Economic Society Annual Conference, New York, USA.

Werner, R. A. (1997). Towards a new monetary paradigm: A quantity theorem of disaggregated credit, with evidence from Japan. *Kredit und Kapital, Duncker & Humblot, Berlin, 30(2)*, 276–309.

Werner, R. A. (2018). Scientific macroeconomics and the quantity theory of Credit; Paper presented to *Centre for Banking, Finance and Sustainable Development*, University of Southampton Business School,1–67.

World Bank (2018). World development indicators for different countries: World Bank publication, Washington, D.C.

World Bank. (2023). World Development Indicators (WDI).

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026357

Correlation Between Reach and Endurance Adversity Intelligence Quotients on Achievement in Physics among Secondary School Students in North-Central, Plateau State, Nigeria

OKORONKA, Ugwumba Augustine[1]
ugwuokoronka@gmail.com
+2348032170136

FWANGLE, Ishaya Istifanius[1]
m.scpse220851@student.mau.edu.ng
+2348069651158

[1]Department of Physical Sciences Education, Modibbo Adama University Yola, Adamawa State, Nigeria

Abstract

This study examined Correlation between Reach and Endurance adversity intelligence Quotients on academic achievement in Physics Concepts among secondary school Students in North-Central, Plateau State, Nigeria. The Study was Guided by three research questions and corresponding null hypotheses tested at 0.05 alpha level, the study was underpinned by Resilience Theory Masten (2001) and Hardiness Theory Kobasa (1979), adopted correlational survey research design with population of 22,959 SSIII students in 2024/2025 academic session. Using Taro Yamane's formula, 387 students were sampled by multiple procedure. Data were collected using two validated instruments namely: Physics Students' Adversity Quotient Questionnaire *(PSAQQ) and* Physics Students' Academic Achievement Proforma *(PSAAP), with Content Validity Index (CVI) = 0.86, Content Validity Ratio (CVR) = 0.87, and Cronbach's alpha reliability of 0.82 for PSAQQ. Mean and standard deviation, linear and multiple regression were used for data analysis of the research questions and hypotheses respectively. Findings showed high level mean score for endurance (3.64), moderate level mean score for reach (3.44). AIQ components had a significant relationship with Physics academic achievement: reach ($r=0.17$, $p<0.05$), endurance ($r=0.16$, $p<0.05$). The composite relationship is revealed by the multiple linear regression model summary revealed ($r=0.20$; adjusted $R^2=0.03$), with significant predictive relationship $F(2, 384)=3.85;p<0.05$). Based on the results it was recommended that reach and endurance AIQ components should be utilized by physics teachers in their pursuit to enhance academic achievement.*

Key Words: *Reach and endurance AIQ, Secondary school, Academic achievement in physics.*

Introduction

Physics forms the foundation of technological innovation and is crucial to national development. It underpins nearly every aspect of life, from the functioning of the human eye through the electromagnetic rays of light powering vision to walking, washing clothes where it absorbs the soapy water through capillarity and breakdown the dirt in cloth thereby making it clean and cooking food through effect of heat either by conduction, convection or radiation to make the raw molecules of food well cooked and delicious (Tyos & Fwangle, 2025). Everyday activities such as the friction enabling us to walk or the blotting of ink on paper through a phenomenon called capillarity are practical Physics applications. Thus, Physics is central to life, and everyone should have a basic understanding of it. Studying Physics can lead to careers in bio-engineering, manufacturing, mining, and construction. In today's digital age, Physics education in secondary schools is crucial, as

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026357

scientific literacy anchored in Physics is essential for all, not just those pursuing Science Technology Engineering and Mathematics (STEM) careers (Frolova et al., 2020; Fasanya & Abdulwaheed, 2023). Despite the importance of Physics to humanity and national development, students' academic achievement in the subject at senior secondary level has remained persistently poor. The 2023 West African Examination Council (WAEC) Chief Examiners' Report noted that fewer than 50% of Physics candidates obtained a credit pass or higher grade required for university admission into Physics dependent fields. This poor performance was attributed to weak student drive, ineffective teaching and learning methods. National WAEC data from 2010 to 2017 shows only an average of four in every ten obtain credit pass while an average of six in every ten failed (Plateau State Ministry of Education, 2024). While this trend of achievement looks partly fair, more effort is required to improve, surpass and sustain it so that Nigeria can take her place among other comity of nations as regards to Science Technology Engineering and Mathematics (STEM) programmes and careers (Knowles et al. 2018). Low enrolment and poor academic achievement in Physics have been attributed partly to the difficult and abstract nature of some concepts in the subject as well as the mathematical/quantitative nature of the subject (Okoronka, 2018). Further, the Physics subject achievement data from 2022 to 2024 at national level revealed only an average of three in every ten obtain credit pass while an average seven in every ten failed, indicating a very low number of students meeting the University admission threshold (PSME, 2024). This raised concerns about students' potential for securing admission into higher institutions to study courses in STEM fields which have stringent requirements. This pattern mirrors the national trend and poses a challenge for Nigeria's aspirations in STEM within the global digital landscape (Knowles et al. 2018; Frolova, et al. 2020). Researchers like, Usman and Jilang (2018); Usman and Mankilik (2019) had affirmed that students' Senior Secondary Certificate Examination (SSCE) Physics results have generally been poor nationally and specifically in Plateau State. Understanding the factors affecting students' academic achievement is crucial for educators and policymakers. Influential factors include individual determination, coping strategies, teacher-student interactions, classroom environment, and socio-economic status. One factor that may be under explored for students' success is the reach and endurance dimensions of adversity intelligence, which may also influence success in every area of human endeavor. Adversity Intelligence Quotient (AIQ) reflects a student's capacity to overcome obstacles, problems, challenges and maintain focus on goals without allowing the situation to overwhelmed the individual's success academically (Stoltz, 1997). Integrating reach and endurance dimensions of AIQ into education can help students build resilience, improve coping skills, and drive academic success through exposure to challenging tasks and guided support (Tripathi & Bajpai, 2022).

The proponent of adversity intelligence quotient maintained that in a world of several challenges and problems especially this present generation where natural disasters like wild fire, hurricane, tsunami, volcanic eruptions and ethnic clashes tamper with normal life calls for adversity intelligence which comprises reach and endurance in this study (Stoltz, 1997). Students may dearly need this intelligence utilized maximally to cope in such difficult times were hunger and pressure from hardship due to global economic meltdown is affecting almost the whole world. This study specifically researches the dimensions of reach and endurance as further discussed, Suryandari and Yuliana, (2021) define the Reach Adversity Intelligence Quotient (RAIQ) dimension as the extent to which difficulties impact one's life. Wang et al. (2021) undertook a study on the analysis of the adversity quotient of students in Macao: A cross-section and correlation study. The study reveals that reach adversity quotient scores were negatively correlated with the coping style of nursing students in Macao. Once again, Mohd and Mohd (2020) undertook a study on the development of the adversity

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026357

quotient index of pre-service teachers in the Institute of Teacher Education Font and the result shows pre-service (students) teachers reach adversity intelligence quotient dimension is at moderate level. Hence from these, one may sustain that the RAIQ dimension is to envision beyond immediate challenges and difficulties; innovate and implement effective strategies to overcome difficulty. Furthermore, Singh and Parveen (2018) maintained that the Endurance Adversity Intelligence Quotient (EAIQ) dimension is how extended to the difficulties and obstacles are tolerated by any person. Also, Espanola (2016) conducted a study and results revealed that EAIQ and academic performance show a weak positive correlation with each other and are not significant. Again, in another study, Mwivanda, (2021) investigated the relationship between adversity intelligence and students' academic performance in public secondary schools in Kenya and the study revealed that the endurance adversity intelligence dimension had a strong positive correlation and significant influence on students' academic performance. On the contrary, Wang, et al. (2021) undertook a study on analysis of the adversity quotient of students in Macao: A cross-section and correlational study. The study reveals that endurance adversity quotient scores were negatively correlated with coping style scores of students in Macao. Regardless of the recognition of students' AIQ as one of the determining factors for academic success as expressed by different researchers, some findings show a positive relationship between adversity intelligence and academic achievement while some otherwise, there is a dearth research based evidence exploring the relationship between students' adversity intelligence dimensions of reach, endurance and academic achievement in first subjects like Physics generally (Mwivanda , 2021; Wang et al. 2021). This study fills a gap, as most adversity intelligence studies globally focus more on other subjects, with limited research on Physics, particularly in Plateau State, North-Central Nigeria. The region faces unique educational challenges, including limited resources, inadequate teacher training, insecurity, and socio-cultural factor impacting student academic achievement. Against this backdrop, there was a need to conduct this research on students' adversity intelligence dimensions of reach, endurance and academic achievement in Physics among secondary schools in Plateau State, Nigeria.

Objectives of the Study

The objectives of the study were, to determine the:

1. Effect of Reach AIQ on academic achievement in Physics among secondary school Students in North-Central region of Plateau State, Nigeria
2. Effect of Endurance AIQ on academic achievement in Physics among secondary school Students in North-Central region of Plateau State, Nigeria
3. Correlation between Reach and Endurance AIQ on academic achievement in Physics among secondary school Students in North-Central region of Plateau State, Nigeria

Research Questions

R_{Q1}: What is the level of reach AIQ in Physics Concepts among senior secondary school Students in North-Central Plateau State?

R_{Q2}: What is the level of Endurance AIQ in Physics Concepts among senior secondary school Students in North-Central Plateau State?

R_{Q3}: What is the mean Academic achievement score among in Physics Concepts among senior secondary school Students in North-Central Plateau State?

Null Hypotheses

H_{01}: There is no significant relationship between reach AIQ and academic achievement in Physics concepts among senior secondary school students in North-Central Plateau State.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026357

H_{02}: There is no significant relationship between endurance AIQ and academic achievement in Physics concepts among senior secondary school students in North-Central Plateau State.

H_{03}: There is no significant relationship between Reach and Endurance AIQ on academic achievement in Physics among senior secondary school Students in North-Central Plateau State.

Literature Review

The study was underpinned by Resilience Theory (Masten, 2001) and Hardiness Theory (Kobasa, 1979). Resilience Theory (RT), as proposed by Masten (2001), defines resilience as the capacity of individuals to successfully adapt or bounce back from adversity, stress, or risk, using internal strengths and external resources, emphasizing ordinary adaptive processes and protective factors like supportive teachers and self-efficacy. Hardiness Theory (HT) by Kobasa (1979), posited as a personality style or pattern associated with continued good health and performance under stress, that enables stress resistance and performance sustainability, comprising commitment, control, and challenge. These theories explain how students navigate academic adversity in Physics, a subject requiring abstract reasoning and problem-solving. Adversity Intelligence Quotient (AIQ) measures students' resilience capacities, capturing the interplay of psychological resilience and hardiness. Students with high AIQ reinterpret setbacks constructively, persevere under challenges, and maintain academic achievement despite difficulties. In Plateau State, Nigeria, where insecurity, poverty, and displacement create learning barriers, fostering resilience and hardiness may enhance Physics academic achievement. The integrated framework of RT and HT offers insights into students' adaptive functioning, shedding light on why some students succeed in Physics despite obstacles. This study examines how resilience and hardiness contribute to academic achievement in Physics among senior secondary schools in Plateau State, Nigeria.

The *reach* component of the Adversity Intelligence Quotient (AIQ) refers to how individuals perceive the extent to which adversity affects various areas of their lives, including academics. Tripathi and Bajpai (2022) define reach as the perceived spread of adversity across life domains. High-reach individuals compartmentalize adversity, preventing it from impacting unrelated areas, while low-reach individuals allow it to spill over, amplifying stress. Singh and Parveen (2018) describe RAIQ as one's perception of how adversity extends beyond the initial issue. Suryandari and Yuliana (2021) observe that low-RAIQ individuals exaggerate problems, disrupting their peace, while high-RAIQ individuals limit adversity's scope and cope better. Hence from these definitions, one may say that the RAIQ dimension is to; (i) envision beyond immediate challenges and difficulties. (ii) Innovate and implement effective strategies to overcome difficulty. (ii) Maintain holistic well-being, ensuring no aspect of life is compromised. Tripathi and Bajpai (2022) found a strong positive correlation between RAIQ and academic achievement ($r = 0.61$, $p < 0.05$) among Indian secondary school students. Mohd and Mohd (2020) reported a moderate RAIQ level in pre-service teachers. Espanola (2016) found a weak, non-significant positive correlation between RAIQ and academic performance. Similarly, Matore & Khairani (2019) reported a very weak but significant correlation. In contrast, Mwivanda (2021) found a strong positive correlation between RAIQ and academic performance in Kenyan secondary students. However, Wang et al. (2021) found a negative correlation between RAIQ and coping styles among Macao nursing students. These varying findings suggest the need for further research, especially among underrepresented secondary school populations. Given the inconsistent findings, more research is necessary to clarify RAIQ's role in academic outcomes. Further, *Endurance Adversity Intelligence Quotient (EAIQ)* reflects a student's ability to persist through prolonged challenges, playing a crucial role in academic success. Tripathi and Bajpai (2022) define endurance as how long one perceives adversity to last, influencing hope, optimism, and perseverance. High

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026357

EAIQ individuals view adversity as temporary and believe solutions exist. Singh and Parveen (2018) describe EAIQ as the tolerance level for prolonged challenges. Matore et al. (2020) identify EAIQ indicators as the ability to anticipate challenge duration and seek solutions. High EAIQ scorers remain optimistic, believing every challenge ends eventually. Suryandari and Yuliana (2021) highlight that low EAIQ individuals see adversity as long-term, causing helplessness and pessimism, while high EAIQ individuals maintain resilience and positivity. From these definitions and discussions raised on the endurance adversity intelligence quotient dimension it is likely to opined that EAIQ is the ability to stay focused on any venture of importance not minding any distraction and hardship until the desired outcomes are obtained at hand. Tripathi and Bajpai (2022) found a low but significant positive correlation between EAIQ and academic achievement ($r = 0.29$, $p < 0.05$). Mwivanda (2021) observed a strong positive correlation between EAIQ and academic performance. Conversely, Espanola (2016) found a weak, non-significant correlation. Mohd and Mohd (2020) reported a high EAIQ level among pre-service teachers. However, Wang et al. (2021) found a negative correlation between EAIQ and coping styles among Macao nursing students. Similarly, Yazon (2019) reported a negative correlation between EAIQ and math proficiency in pre-service teachers. Given the mixed findings, further research is warranted to understand both RAIQ and EAIQ's full impact within the AIQ framework.

Research Methodology

This study employed a correlational survey design to examine relationships among variables without manipulation, enabling the identification of positive or negative associations (Bhandari, 2022). The study was conducted in Plateau State, Nigeria, comprising 17 Local Government Areas in the north-central region (NEWMAP, 2019). The population consisted of 22,959 SSIII Physics students in 311 public senior secondary schools, from which a sample of 387 students was drawn using Yamane's formula through a multistage sampling procedure (Yamane, 1973). Two instruments were used for data collection: The Physics Students' Adversity Quotient Questionnaire (PSAQQ) and the Physics Students' Academic Achievement Proforma (PSAAP). The PSAQQ was adapted from the Adversity Quotient Profile developed by Stoltz (1997) and structured on a five-point Likert scale to assess reach and endurance dimensions in Physics learning. The adapted PSAQQ has the following response modes Very High Level (VHL) = 5 points, High Level (HL) = 4 points, Moderate Level (ML) = 3 points, Low Level (LL) = 2 points and Very Low Level (VLL) = 1 point, Stoltz (1997). The PSAAP was used to obtain students recorded academic scores across three terms for the 2023/2024 session. The instruments were validated by experts in educational psychology, measurement and evaluation, and Physics education. Content validity indices were satisfactory (CVI = 0.85; CVR = 0.87), indicating adequacy (Genareo, 2023). Reliability of the PSAQQ was established through test–retest, yielding a Cronbach's alpha of 0.815, with subscale coefficients of 0.756 and 0.754, demonstrating good internal consistency (Taber, 2018). Data were collected through direct administration of instruments to respondents. Descriptive statistics (mean and standard deviation) were used to answer the research questions. The decision rule was based on real limits of numbers of; Very High Level (VHL) 4.50-5.00, High Level (HL) 3.50-4.49, Moderate Level (ML) 2.50-3.49, Low Level 1.50-2.49, Very Low Level 0.10-1.49. Hypotheses were tested using linear and multiple regression analyses at a 0.05 level of significance. The decision rule is based on predefined P-value at 0.05 level of alpha significance; when calculated ($P < 0.05$), the decision is to reject the null hypothesis that there is a statistically significant relationship. If the p-value ($P > 0.05$), the decision is that the null hypothesis was not be rejected, that there is no statistically significant relationship.

Presentation of Results

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026357

The results are presented in order of objectives, research questions and null hypotheses:

Research Question One:

What is the level of reach AIQ in Physics Concepts among senior secondary school Students in North-Central Plateau State?

Answering Research Question One:

Table 1: Mean and Standard Deviation of Reach AIQ Level Among Students Offering Physics in Senior Secondary School in Plateau State

S/N	ITEM (n = 387)	Mean	S. D	Remark
1	Difficulties in Physics are temporal and can be overcome.	3.39	1.01	ML
2	When I encounter a challenging Physics problem. I do not let it affect my overall confidence in the subject.	3.33	0.98	ML
3	I separate my performance in Physics from my abilities in other subjects.	3.43	1.02	ML
4	I view setbacks in Physics as isolated incident rather than signs of failure.	3.45	1.06	ML
5	My struggle in Physics do not define my overall academic capability.	3.41	1.04	ML
6	I am able to maintain focus on my Physics goals, even when faced with challenges.	3.48	1.10	ML
7	One poor performance in Physics does not predict my future results.	3.44	1.13	ML
8	I classify my experience in Physics from my experiences in other areas of life.	3.49	0.94	ML
9	I often remind myself that challenges in Physics are part of learning process.	3.47	0.93	ML
10	I am confident that I can improve my Physics skills, regardless of setback.	3.49	0.97	ML
	Grand Mean	3.44	1.02	ML

Source: (Field Survey Work, 2025)

Data on Table 1 examines the level of reach AIQ among the students. The overall mean score is 3.44 with a standard deviation of 1.02, indicating a Moderate Level (ML) of reach AIQ.

Null Hypotheses

H_{01}: There is no significant relationship between reach AIQ and academic achievement in Physics concepts among senior secondary school students in North-Central Plateau State.

Testing Hypothesis One:

Table 2a: Summary of Linear Regression Analysis of Relationship between Reach AIQ and Students' Academic Achievement in Physics in Secondary Schools of Plateau State

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1729.704	1	1729.704	9.434	.002[b]
	Residual	70587.970	385	183.345		
	Total	72317.674	386			

Source: (Field Survey Work, 2025)

a. Dependent Variable: Students' Academic Achievement

b. Predictors: (Constant), reach AIQ

Table 2a (ANOVA summary) reveals the overall model is statistically significant, with $F(1, 385) = 9.434$, $p = 0.002$ ($p < 0.05$), meaning reach AIQ explains variance in Physics achievement beyond

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026357

chance. This suggests the predictor improves model fit compared to an intercept-only model. The linear regression analysis rejects the null hypothesis (Ho3), indicating a significant positive relationship between reach AIQ and students' academic achievement in Physics among senior secondary schools in Plateau State.

Table 2b: Model Summary of Relationship between Reach AIQ and Students' Academic Achievement in Physics in Secondary Schools of Plateau State

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.155[a]	.024	.021	13.54051

Source: (Field Survey Work, 2025)

a. Predictors: (Constant), reach AIQ

Table 2b shows a moderate correlation (R = 0.155) and modest explanatory power, as reach AIQ accounts for about 2.1% of the variance in academic achievement (R^2 = 0.021). The standard error of the estimate (13.54051) indicates typical prediction errors around 13.54 units on the achievement scale.

Table 2c: Coefficient of Beta of Relationship between Reach AIQ and Students' Academic Achievement in Physics in Secondary Schools of Plateau State

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	52.734	4.456		11.835	.000
	reach AIQ	3.385	1.102	.155	3.072	.002

Source: (Field Survey Work, 2025)

a. Dependent Variable: Students' Academic Achievement

Table 2c confirms the positive effect: for each one-unit increase in reach AIQ, Physics achievement rises by 3.385 units (unstandardized B = 3.385, SE = 1.102, t = 3.072, p = 0.002), with a standardized beta of 0.155 showing small-to-moderate influence in standard deviation terms. The constant (52.734, p < 0.001) represents baseline achievement without reach AIQ.

Research Question Two:

R_{Q2}: What is the level of Endurance AIQ in Physics Concepts among senior secondary school Students in North-Central Plateau State?

Answering Research Question Two:

Table 3: Mean and Standard Deviation of Level of Endurance AIQ among Students Offering Physics in Senior Secondary School in Plateau State.

S/N	ITEM (n = 387)	Mean	S. D	Remark
1	I focus on my Physics, even when I encounter difficult concepts.	3.62	0.92	HL
2	When faced with challenging Physics problems, I am determined to find a solution.	3.67	0.93	HL
3	Persistence is essential for mastering Physics.	3.53	0.94	HL
4	Even after making mistakes in Physics, I continue to try until I understand the material.	3.59	1.03	HL
5	I am confident in my ability to overcome obstacles in Physics.	3.75	0.95	HL
6	I often seek additional resources (tutoring, online) when I struggle with Physics topics.	3.56	1.01	HL
7	I view challenging Physics tasks as opportunities to improve my skills.	3.89	1.02	HL
8	I maintain a positive attitude when faced with Physics assignments.	3.71	0.97	HL

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026357

9	I am willing to spend extra time studying Physics when I find it challenging.	3.62	1.00	HL
10	I improve my Physics skills in the face of setback.	3.49	1.26	ML
	Grand Mean	3.64	1.00	HL

Source: (Field Survey Work, 2025)

Data on Table 3 evaluates the level of endurance AIQ among Physics students in senior secondary schools in Plateau State. The overall mean score is 3.64 with a standard deviation of 1.00, indicating a High Level (HL) of endurance.

Hypothesis Two:

H_{02}: There is no significant relationship between endurance AIQ and academic achievement in Physics concepts among senior secondary school students in North-Central Plateau State.

Testing Hypothesis Two:

Table 4a: Summary of Linear Regression Analysis of Relationship between Endurance AIQ and Students' Academic Achievement in Physics in Secondary Schools of Plateau State

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1978.260	1	1978.260	10.828	.001[b]
	Residual	70339.415	385	182.700		
	Total	72317.674	386			

Source: (Field Survey Work, 2025)

a. Dependent Variable: Students' Academic Achievement

b. Predictors: (Constant), endurance AIQ

Table 4a shows that the regression analysis yielded F(1,385) = 10.828, p = .001. Since the p-value is less than the 0.05 level of significance, the regression model is statistically significant. This means endurance AIQ significantly predicts students' academic achievement in Physics. The null hypothesis is rejected. Endurance component of AIQ has a significant influence on students' academic achievement in Physics.

Table 4b: Model Summary of Relationship between Endurance AIQ and Students' Academic Achievement in Physics in Secondary Schools of Plateau State

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.165[a]	.027	.025	13.51665

Source: (Field Survey Work, 2025)

a. Predictors: (Constant), endurance AIQ

Table 4b presents a correlation coefficient of R = .165, indicating a positive relationship between endurance AIQ and students' academic achievement. The adjusted R^2 = .025 shows that endurance AIQ accounts for approximately 2.5% of the variation in students' academic achievement in Physics after adjusting for sample size and model bias, while about 97.5% of the variation is explained by other variables not included in the model. The standard error of estimate (13.52) reflects the average prediction error. Endurance component of AIQ has a weak positive predictive strength on students' academic achievement in Physics.

Table 4c: Coefficient of Beta of Relationship between Endurance AIQ and Students' Academic Achievement in Physics in Secondary Schools of Plateau State

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	52.654	4.190		12.565	.000
	Endurance AIQ	3.422	1.040	.165	3.291	.001

Source: (Field Survey Work, 2025)

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026357

a. Dependent Variable: Students' Academic Achievement

Table 4c indicates that endurance AIQ significantly contributes to students' academic achievement (β = .165, t = 3.291, p = .001). This implies that a one standard deviation increase in endurance AIQ leads to a 0.165 standard deviation increase in students' achievement. The unstandardized coefficient (B = 3.422) shows that a one-unit increase in endurance AIQ increases the achievement score by about 3.422 units, while the constant value (52.654) represents the predicted achievement score when endurance component of AIQ is zero. Endurance AIQ positively and significantly predicts students' academic achievement in Physics, though the magnitude of the effect is small.

Answering Research Question Three:

R_{Q3}: What is the mean Academic achievement score among in Physics Concepts among senior secondary school Students in North-Central Plateau State?

Table 5: Mean and Standard Deviation of Academic Achievement Score Among Students offering Physics in Senior Secondary School in Plateau State

Variable	N	Mean	S. D
students' academic achievement	387	56.3514	13.75302

Source: (Field Survey Work, 2025)

Table 5 data reports the mean academic achievement score among students offering Physics in senior secondary schools in Plateau State. With a sample size of 387 students, the mean academic achievement score is 56.35, with a standard deviation of 13.75. This shows that on average, students' achievement in Physics is moderate with a considerable variation in their academic achievement levels.

Hypothesis Three:

H_{03}: There is no significant relationship between Reach and Endurance AIQ on academic achievement in Physics among senior secondary school Students in North-Central Plateau State.

Testing Hypothesis Three:

Table 6a: Summary of ANOVA from Multiple Regression Analysis of Relationship between Adversity Intelligence Quotient (Reach and Endurance) and Students' Academic Achievement in Physics

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2802.369	2	700.592	3.850	.004[b]
	Residual	69515.306	384	181.977		
	Total	72317.674	386			

Source: (Field Survey Work, 2025)

a. Dependent Variable: Students' Academic Achievement

b. Predictors: (Constant), Reach, and Endurance.

The analysis results in Table 6a summarize an ANOVA-based multiple linear regression analysis used to determine if there is a significant predictive relationship between students' adversity intelligence quotient (including reach and endurance) and academic achievement in Physics. The results showed that F(4, 382) = 3.850, P=0.004< 0.05. As the P-value (0.004) is below the 0.05 significance threshold and therefore, the null hypothesis was rejected. This implies that AIQ four sub-variables is significant to students' academic achievement in Physics with a positive significant relationship between adversity intelligence quotient and academic achievement in Physics in senior secondary schools of Plateau State.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026357

Table 6b: Model Summary from Multiple Regression Analysis of Relationship between Adversity Intelligence Quotient (Reach and Endurance) and Students' Academic Achievement in Physics

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.197[a]	.039	.029	13.48989

Source: (Field Survey Work, 2025)

a. Predictors: (Constant), Reach, Endurance.

Table 6b presents a model summary illustrating how the independent variable explains the variance in the dependent variable. The results indicate that 2.9% of the variation in academic achievement can be attributed to adversity intelligence quotient, including reach, and endurance. The r-value of 0.197[a] indicates a weak positive relationship between adversity intelligence quotient and academic achievement.

Table 6c: Coefficients of Beta from Multiple-Linear Regression Analysis of Relationship between Adversity Intelligence Quotient (Reach and Endurance) and Students' Academic Achievement in Physics

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	46.098	5.259		8.766	.000
	Reach AIQ	1.045	1.500	.048	.696	.487
	Endurance AIQ	.655	1.705	.032	.384	.701

Source: (Field Survey Work, 2025)

a. Dependent Variable: Students' academic achievement

Table 6c presents the individual contributions of reach and endurance components of AIQ to students' academic achievement in Physics when all variables are considered together in a multiple regression model. The constant value (B = 46.098, t = 8.766, p = .000) represents the predicted academic achievement score when reach and endurance dimensions are held at zero.

For the individual predictors, Reach AIQ produced β = .048, t = .696, p = .487, which is not statistically significant because the p-value exceeds the 0.05 level. This suggests that Reach AIQ does not make a meaningful unique contribution to academic achievement when the other dimensions are included in the model. Endurance AIQ had β = .032, t = .384, p = .701, which is also not significant. Therefore, endurance AIQ does not independently predict students' academic achievement in Physics after accounting for reach and endurance dimensions of AIQ. Overall, although each AIQ dimension earlier showed relationships with achievement individually, the multiple regression results indicate that none of the AIQ components makes a significant unique contribution to students' academic achievement in Physics when considered simultaneously. This suggests that their predictive effects overlap and none stands out as an independent predictor in the combined model.

Discussion of Findings

This study examined the relationship between reach and endurance components of AIQ and academic achievement in Physics in secondary schools in Plateau State, Nigeria. The results indicated that students demonstrated a level of the reach dimension found to be moderate. Reach reflects students' ability to prevent academic setbacks from affecting other aspects of their functioning. Although the correlation coefficient indicates a weak positive relationship, it was statistically significant ($p < 0.05$). This suggests that students who are able to compartmentalize

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026357

academic difficulties may experience slight improvements in academic achievement. The finding is consistent with previous studies (Tripathi & Bajpai, 2022; Mwivanda, 2021; Matore & Khairani, 2019). This contrasts with studies reporting non-significant relationships (Espanola, 2016) and negative relationships (Wang et al., 2021; Yazon, 2019). Endurance recorded a high mean level (3.64), indicating that students generally perceived academic challenges as temporary and manageable. The dimension showed a statistically significant relationship with Physics academic achievement. Although the explained variance was modest, the weak positive relationship suggests that persistence and sustained effort contribute meaningfully to academic success in Physics. Students who view difficulties as transient are more likely to remain engaged during demanding tasks such as numerical problem-solving and conceptual analysis. This result is consistent with the findings of Mwivand (2021); Tripathi and Bajpai (2022), who reported positive and significant relations between endurance and academic outcomes. However, it diverges from studies that found non-significant relationships (Espanola, 2016) and studies with negative relationships (Wang et al. 2021; Yazon, 2019). When the two dimensions were examined collectively through multiple regression analysis, the model was statistically significant, but the total variance explained was relatively small. This indicates that while reach and endurance dimensions jointly relate to Physics achievement, their predictive power is limited. The weak overall correlation suggests that other variables which were not in the model may exert stronger influences on students' academic outcomes. This may be the reason why individual beta coefficients in the regression model were not statistically significant when controlled simultaneously, reach and endurance demonstrated relative contribution among the predictors with a value of 4.80% and 3.2%respectively.

Conclusion

The study therefore concludes that reach and endurance components of AIQ may enhance persistence and adaptive coping in learning Physics by strengthening students' resilience through integrated improvements and learning support systems since the strength of relationship is weak.

Recommendations

1. It was recommended that reach AIQ components should be utilized by physics educators in their pursuit to enhance academic achievement in Physics.
2. Since endurance dimensions of AIQ significantly relate with Physics academic achievement, teachers should sustain endurance among students in problem-solving activities to balance adversity resilience with academic competence.

References

Bhandari, P. (2022). *What is quantitative research? | Definition, uses & methods.* *https://www.scribbr.com/methodology/quantitative-research/*

Española, R.P. (2016). Adversity quotient and academic performance of selected students in MSU Marawi City. *Proceedings Journal of Education, Psychology and Social Science Research, 3*(1), 57-63.

Fasanya, A. G & Abdulwaheed, O. I. (2023). Physics education: Bedrock for achieving security and sustainable national development. *Journal of Science, Technology and Mathematics Pedagogy, 1*(1), 50-58

Field Survey Work (2025). *Data analyzed from the raw information gathered from the fieldwork in all the thirty-six sampled senior secondary schools.* Plateau State.

Frolova, E. O., Rogach, O. V & Ryabova, T. M. (2020). Digitalization in modern scientific discourse: New trends and risks analysis. *European Journal of Contemporary Education, 9*(2), 313-334.

Genareo, V. R. (2023). *Using Microsoft Excel to calculate content validity index (CVI) and content validity ratio (CVR): A practical approach [Paper presentation]. 2023 AAQEP Quality Assurance Symposium,* Indianapolis, IN, USA.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026357

Knowles, J. G., Kelley, T. R & Holland, J. D. (2018). Increasing teacher awareness of STEM careers. *Journal of STEM Education 19*(3), 47-55.

Kobasa, S. C. (1979). Stressful life events, personality, and health: An inquiry into hardiness. *Journal of Personality and Social Psychology, 37*(1), 1–11.

Masten, A. S. (2001). Ordinary magic: Resilience processes in development. *American Psychologist, 56*(3), 227–238.

Matore, E. M.; Al Hapiz, N. M., & Matore, E. R. M. (2020). The characteristics of quitters, campers and climbers of adversity quotient on polytechnic students from gender perspectives. *Proceedings of Mechanical Engineering Research Day 2020,* pp. 257-258,

Matore, M.E & Khairani, A.Z. (2019). Perhubungan antara adversity quotient dengan Pencapaian Akademik Pelajar. *GJAT | Special issue |* pages 63 – 78.

Mohd, A. R., & Mohd, M. M. E. E. (2022). Development of adversity quotient index of pre-service teachers in Institute of Teacher Education (IPG). *Front. Public Health 10:940323.*

Mwivanda, M. (2021). *Relationship between teachers' adversity quotient and students' academic performance in public secondary schools in Kiambu and Nairobi counties, Kenya.* A Thesis Submitted in Partial Fulfilment for the Requirements of Doctor of Philosophy in the Department of Educational Management, Policy and Curriculum Studies, School of Education, Kenyatta University

Nigeria Erosion and Watershed Management Project (NEWMAP) (2019). *Environmental and Social Management Plan (ESMP) for Yakubu Gowon dam in Plateau State*. Draft Report, December, 2019.

Okoronka, A. U. (2018). Effects of concept mapping instructional strategies and gender on secondary students' achievement in difficult physics concepts in Yola, Nigeria. *Gombe Journal of Education, 2*(1), 1 – 12.

Plateau State Ministry of Education (2024): *Department of planning and statistics; information on students' enrollment for 2024/2025 and previous WAEC academic performance in the State.* Educational Resource Centre, Jos, Plateau State.

Singh, K., & Parveen, S. (2018). Impact of adversity quotient on learning behavior among secondary school students. *Indian Journal of Public Health Research & Development, 9*(12), 1772-1779.

Stoltz, P. G. (1997). *Adversity quotient: Turning obstacles into opportunities.* John Wiley and Sons.

Suryandari, S & Yuliana, L. (2023). The effect of adversity quotient (AQ) on natural science learning outcomes in elementary school students Surabaya, Indonesia. *Journal of Education Research, 4*(2), 599-606

Taber, K. S. (2018). The use of Cronbach's Alpha when developing and reporting instruments in science education. *Res Sci educ, (2018) 48:*1273-1296.

Tripathi, A & Bajpai, A. (2022). A study of influence of adversity quotient on academic achievement of adolescent's stage. *The National Life Skills, Value Education & School Wellness Program IJSHW, 8*(1). 7-11.

Tyos, D. D & Fwangle, I. I. (2025). Impact of information communication technology on teaching physics in post covid-19-era in Jos South, Plateau State, Nigeria. *International Journal of Research in Science, Technology and Mathematics Education (IJRSTME) Conference Paper, 11*(1), 11-19.

Usman, I. S. & Jilang, W. W. (2018). Effects of computer-assisted instruction on students' achievement and interest in secondary school physics in Jos North Local Government Area of Plateau State, Nigeria. *KIU Journal of Social Sciences 4*(1), 105–114.

Usman, I. S., & Mankilik, M. (2019). Effects of Concept Mapping Strategy on Secondary School Physics Students' Achievement in Jos, Plateau State, Nigeria. *KIU Journal of Humanities, 4*(3), 117–126.

Wang, X., Liu, M., Tee, S & Dai (2021). Analysis of adversity quotient of nursing students in Macao: A cross section and correlation study. *International Journal of Nursing Sciences, 8*(2021), 204-209.

West African Examination Council (2023*). Chief Examiner's report (Nigeria).* Lagos: WAEC

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026357

Yamane, T. (1967). *Statistics. An Introductory Analysis (2nd Edition).* New York: Harper and Row.

Yazon, A. (2019). Pre-service teachers' adversity quotient and proficiency in English language and Mathematics. *Universal Journal of Educational Rsearch 7*(12), 2670-2676.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026358

Effects of Jigsaw and Numbered-Head-Together Instructional Strategies on Achievement and Retention in Algebraic Concept among Secondary School Students in Minna Metropolis, Niger State, Nigeria

AUDU, Samson[1]
sampsonaudu@gmail.com
08036077609

GIMBA, Ramatu W.[1]
Ramatu.gimba@futminna.edu.ng
08032853603

ABDULRAHMAN, Muhammad Alfa[1]
Ma.abbul@futminna.edu.ng
07035370004

[1]Department of Science Education, School of Science and Technology Education, Federal University of Technology, Minna, Niger State, Nigeria

Abstract

This study investigated the effects of Jigsaw and Numbered Heads Together (NHT) instructional strategies on students' achievement and retention in algebra among senior secondary school students in Minna Metropolis, Niger State, Nigeria, with particular attention to the inclusion of a control (conventional teaching) group and the influence of gender. A quasi-experimental, non-equivalent control group pre-test, post-test design was adopted. The population comprised 1,892 SS II students in public secondary schools in Minna Metropolis, from which a sample of 349 students was purposively selected from five schools. Two schools constituted Experimental Group I (Jigsaw, n = 124), two schools constituted Experimental Group II (NHT, n = 141), and one school served as the Control Group (conventional method, n = 84), comprising 190 males and 159 females. Data were collected using the Algebra Achievement Test (AAT) and Algebra Retention Test (ART), each consisting of 40 multiple-choice items adapted from WAEC past questions (2014–2023). The instruments were validated by experts, and reliability coefficients of 0.92 (AAT) and 0.89 (ART) were obtained using the KR-20 method. Data were analysed using mean, standard deviation, One-way Analysis of Variance (ANOVA), and independent samples z-test at the 0.05 level of significance. The results revealed a statistically significant difference in students' achievement scores among the three groups, $F(2, 346) = 18.647$, $p < 0.05$. Post-hoc analysis indicated that students taught using NHT achieved the highest scores, followed by those taught using Jigsaw, while the control group recorded the lowest performance. Similarly, a significant difference was observed in retention scores, $F(2, 346) = 26.843$, $p < 0.05$, with NHT producing the highest retention, followed by Jigsaw, and the control group showing the least retention.

Keywords: Jigsaw, Numbered-Head-Together, Algebra, Achievement

Introduction

Mathematics occupies a central position in the Nigerian senior secondary school curriculum and is recognised as a compulsory subject because of its indispensable role in national development, technological advancement, and everyday problem-solving. The Federal Ministry of Education emphasises that mathematics equips learners with logical reasoning, quantitative skills, and analytical abilities needed for success in science, engineering, commerce, and modern societal demands. Within the mathematics curriculum, algebra stands as a core component, serving as the gateway to higher-order topics such as trigonometry, calculus, and advanced statistics. However, persistent reports of students' weak performance in algebra across Nigerian schools highlight the need to strengthen instructional practices and improve learner outcomes. According to Adeoye

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026358

(2024), enhancing students' foundational understanding of algebra is critical, as it forms the backbone of mathematical proficiency required for both academic and real-life applications. Algebra is one of the foundational topics in secondary school mathematics, playing a pivotal role in students' ability to engage with more advanced mathematical concepts such as calculus and geometry. Despite its importance, many students encounter difficulties in understanding and retaining algebraic concepts, often resulting in low achievement scores. Studies by Yahaya *et al.* (2020) indicated that the abstract nature of algebra contributes to students' struggles, making it difficult for them to conceptualize and apply the principles learned in class. These challenges have raised questions about the effectiveness of conventional teaching methods, which tend to be more teacher-centeredand less engaging. Consequently, there is a need for alternative teaching strategies that can improve both achievement and retention in algebra. One of the most promising alternatives to traditional instruction is cooperative learning, a teaching approach where students work together to achieve shared learning goals.

Cooperative learning strategy refers to an instructional method in which students work together in small groups to achieve shared learning objectives, helping one another understand concepts while developing interpersonal and cognitive skills. This approach encourages mutual accountability, discussion, and peer-assisted problem solving, making learning more interactive and meaningful. Research by Johnson and Johnson (2019) shows that cooperative learning enhances student engagement and promotes deeper understanding of academic content. Cooperative learning strategies, such as Jigsaw and Numbered Heads Together (NHT), emphasize students' collaboration and interaction, which have been found to positively impact both academic achievement and retention (Slavin, 2020). These strategies create an environment where students not only acquire knowledge but also develop critical thinking, communication, and problem-solving skills, all of which are essential for mastering algebra. One such strategy that exemplifies these benefits is the Jigsaw method, which emphasizes collaborative learning through peer teaching and shared responsibility. The Jigsaw instructional strategy is a cooperative learning approach in which instructional content is divided into segments, and each student in a small group is assigned responsibility for mastering and teaching a specific portion of the material to their peers (Slavin, 2020). Students first meet in "expert groups" to study and discuss their assigned topics before returning to their original groups to share their understanding. This structure promotes active engagement, individual accountability, and interdependence among learners (Okoli and Adamu, 2021). Studies conducted in Mathematics and other subjects have reported significantly higher achievement scores for students taught using Jigsaw compared to those taught with conventional methods, suggesting that collaborative peer teaching improves comprehension and performance (Johnson *et al.*, 2021; Yemi *et al.*, 2025). The Numbered Heads Together (NHT) instructional strategy, developed by Kagan (1989), is a cooperative learning approach that fosters collaboration and active participation among students. In this strategy, learners work in small groups to discuss and solve academic problems, with one member randomly selected to present the group's response. Unlike the Jigsaw method, NHT emphasizes equal contribution from all group members, as any student may be called upon to report the group's answer. Research indicates that the NHT strategy enhances student engagement and participation, as the possibility of being randomly selected motivates learners to remain attentive and contribute meaningfully to group discussions (Yusuf *et al.*, 2020).

Retention, defined as the ability to recall and apply learned concepts over time, is a critical variable in educational success. A study carried out by Lee and Kim (2021) revealed that students taught

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026358

using the Jigsaw strategy retained Algebra concepts more effectively than those exposed to the Numbered Heads Together (NHT) method. The Jigsaw approach promotes retention by requiring students to master a segment of content and teach it to their peers, reinforcing understanding through repetition and active engagement. Similarly, the NHT strategy enhances retention by ensuring that all group members contribute to problem-solving, as any student may be randomly selected to present the group's solution, thereby maintaining attentiveness and accountability (Yusuf *et al.*, 2020). Some studies have shown that teaching methods emphasizing peer interaction, collaborative discussion, and repeated engagement with content significantly improve long-term retention of learned concepts (Brown and Taylor, 2022; Miller, 2019). By fostering active participation, shared responsibility, and repeated exposure to Algebraic content, cooperative learning strategies like Jigsaw and NHT support not only immediate achievement but also the sustained retention of knowledge, which is essential for continuous learning and mastery of mathematical concepts. While both the Jigsaw and Numbered Heads Together (NHT) strategies have been shown to enhance student achievement (Jack and Yawe, 2023; Smith *et al.,* 2020), their impact on retention is particularly significant. Retention the ability to recall and apply learned material over time is a key indicator of long-term academic success (Brown and Taylor, 2022). Studies have indicated that students exposed to cooperative learning approaches demonstrate higher retention rates than those taught via traditional methods, as active engagement promotes deeper cognitive processing and memory consolidation (Ibrahim *et al.*, 2022). In the context of Algebra, a concept characterized by abstraction and the integration of multiple mathematical ideas, the Jigsaw strategy enables students to master discrete units before teaching them to peers, while NHT encourages collaborative problem-solving, fostering critical understanding of algebraic principles. Furthermore, these strategies may enhance self-efficacy, communication, and teamwork skills, which collectively contribute to sustained achievement. Given these benefits, it is important to examine whether gender differences moderate the effectiveness of Jigsaw and NHT on students' retention and achievement in Algebra concepts. Both Jigsaw and NHT strategies represent powerful tools for enhancing students' achievement and retention in Algebra concepts. By fostering collaboration, accountability, and active engagement, these strategies promote deeper understanding of algebraic principles and improve learners' ability to retain and apply knowledge over time. Nonetheless, further research is necessary to compare the relative effectiveness of these strategies and to determine optimal implementation in diverse educational settings. This study aims to address this gap by exploring the effects of the Jigsaw and NHT strategies on students' achievement and retention in Algebra concepts.

Statement of the Research Problem

Persistent poor performance in Mathematics is a major challenge in Nigerian secondary schools, particularly in Minna metropolis, Niger State. A credit pass in Mathematics is required for admission into most science and technology-based courses at tertiary institutions; thus, low achievement limits students' opportunities and undermines national technological and economic development (Abimbola, 2020; Haruna and Wushishi, 2025). Examination results reflect this problem: in 2025, NABTEB recorded a 94.60% credit pass rate, NECO 60.26%, while WAEC reported only 38.32% of candidates achieving credits in at least five subjects, including Mathematics and English Languagethe lowest since 2015 (NABTEB, 2025; NECO, 2025; WAEC, 2025. Algebra has been identified as a major contributor to this underachievement due to its abstract and cumulative nature (Iroko and Olaoye, 2022). Factors contributing to poor performance include inadequate instructional facilities, shortage of qualified teachers, Mathematics anxiety, cultural beliefs, gender stereotypes, and reliance on teacher-centred methods (Iroko and Olaoye, 2022; Zakaria *et al.*, 2023). Cooperative learning strategies, such as the Jigsaw and Numbered Heads Together (NHT) methods, have shown

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026358

promise in improving engagement and achievement. However, most studies have focused on other subjects, measured only short-term outcomes, or failed to compare multiple strategies in the same context. In Minna metropolis, there is a need to investigate the effectiveness of instructional strategies on students' achievement and retention of algebraic concepts. This study aims to fill this gap by investigating the effects of Jigsaw and NHT strategies on students' academic achievement and retention in Algebra

Aim and Objectives of the Study

The aim of this study is to investigate the effects of the Jigsaw and Numbered Heads Together (NHT) cooperative learning strategies on students' achievement and retention in algebra among senior secondary school students in Minna metropolis. The objectives of this study are to:

i. Determine the effects of Jigsaw and Numbered Heads Together (NHT) strategies on achievement in algebraic concepts among senior secondary school students in Minna Metropolis
ii. Examine the effects of Jigsaw and Numbered Heads Together (NHT) strategies on retention of algebraic concepts among senior secondary school students in Minna Metropolis

Research Questions

The following research questions will be asked and answered in this study:

i. What is the difference in the mean achievement scores of senior secondary school students taught algebraic concepts using Jigsaw strategy and those exposed to Numbered Heads Together (NHT) strategy in Minna Metropolis?
ii. What is the difference in the mean retention scores of senior secondary school students taught algebraic concepts using Jigsaw strategy and those exposed to Numbered Heads Together (NHT) strategy in Minna Metropolis?

Research Hypotheses

The following null hypotheses will be tested at the 0.05 level of significance:

H_{01}: There is no significant difference in the mean achievement scores of senior secondary students taught algebraic concepts using the Jigsaw strategy and those taught using the NHT strategy.

H_{02}: There is no significant difference in the mean retention scores of algebraic concepts between students taught algebraic concept using the Jigsaw strategy and those taught using the NHT strategy.

Research Methodology

This study adopted a quasi-experimental design, specifically a non-equivalent control group pre-test/post-test design, to investigate the effects of Jigsaw and Numbered Heads Together (NHT) strategies on the achievement and retention of algebraic concepts among senior secondary school students in Minna Metropolis, Niger State. Two experimental groups were formed: one group received instruction through the Jigsaw strategy, while the other was taught using the NHT strategy. A control group was exposed to traditional teacher-centred instructional methods. Pre-tests were administered to all groups prior to the intervention to establish baseline performance in algebraic concepts and ensure comparability among the groups. Following this, the respective instructional strategies were implemented over a specified period. Upon completion of the intervention, post-tests were conducted to measure students' achievement and retention of algebraic concepts. This design enabled the researcher to evaluate the relative effectiveness of Jigsaw and NHT strategies in enhancing student learning outcomes, while accounting for initial differences in students' prior knowledge. Quantitative data from the pre-tests and post-tests were analysed to answer the research questions and test the hypotheses.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026358

Presentation of Results

Research Question One:

What is the difference in the mean achievement scores of senior secondary school students taught algebraic concepts using the Jigsaw strategy, the Numbered Heads Together (NHT) strategy, and conventional teaching method?

To answer research question one, Mean and Standard Deviation were used to determine the achievement gains. The results are presented in Table 1.

Table 1: Mean and Standard Deviation of Achievement Scores of Students Taught Algebraic Concepts Using Jigsaw, NHT, and Conventional Strategies

Group	Strategy	N	Pretest		Posttest		Mean Gain
			$\bar{x}_1$	SD_1	$\bar{x}_2$	SD_2	
Experimental I	Jigsaw	124	25.69	9.78	43.78	10.63	18.08
Experimental II	Numbered Heads Together	141	27.47	10.99	47.12	11.00	19.65
Control Group	Conventional	84	26.42	9.85	38.45	8.92	12.03

$\bar{x}_1$: Mean of Pretest; SD_1= Standard Deviation of Pretest; $\bar{x}_2$: Mean of Posttest; SD_2= Standard Deviation of Posttest

Table 1. shows that all three groups demonstrated improvement from pretest to posttest. Students taught using the Jigsaw strategy (Experimental Group I) obtained a pretest mean score of 25.69 (SD = 9.78), while their posttest mean score increased to 43.78 (SD = 10.63), resulting in a mean gain of 18.08. Students taught using the Numbered Heads Together strategy (Experimental Group II) recorded a pretest mean score of 27.47 (SD = 10.99) and a posttest mean score of 47.12 (SD = 11.00), yielding a mean gain of 19.65. In contrast, students in the Control Group exposed to conventional teaching methods achieved a pretest mean of 26.42 (SD = 9.85) and a posttest mean of 38.45 (SD = 8.92), with a mean gain of only 12.03. The results indicate that both cooperative learning strategies (Jigsaw and NHT) substantially improved students' achievement in algebraic concepts compared to conventional instruction. However, the group exposed to the Numbered Heads Together strategy achieved the highest mean gain (19.65), followed by the Jigsaw group (18.08), while the Control group demonstrated the lowest gain (12.03). This reveals a clear hierarchy of instructional effectiveness: Numbered Heads Together > Jigsaw > Conventional teaching method.

Research Question Two:

What is the difference in the mean retention scores of senior secondary school students taught algebraic concepts using the Jigsaw strategy, the Numbered Heads Together (NHT) strategy, and conventional teaching method?

To answer research question two, mean and standard deviation were used to determine the retention levels. The results are presented in Table 2.

Table 2: Mean and Standard Deviation of Retention Scores of Students Taught Algebraic Concepts Using Jigsaw, NHT, and Conventional Strategies

Group	Strategy	N	Posttest		Retention		Mean Loss
			$\bar{x}_2$	SD_2	$\bar{x}_3$	SD_3	
Experimental I	Jigsaw	124	43.78	10.63	40.57	9.88	3.21

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026358

Experimental II	Numbered Heads Together	141	47.12	11.00	44.94	10.07	2.18
Control Group	Conventional	84	38.45	8.92	32.18	7.85	6.27

$\bar{x}_2$: Mean of Posttest; SD_2= Standard Deviation of Posttest; $\bar{x}_3$: Mean of Retention; SD_3= Standard Deviation of Retention

Table 2 shows that all three groups experienced some decay in knowledge retention over time; however, the magnitude of loss varied substantially across instructional conditions. Students taught using the Jigsaw strategy (Experimental Group I) obtained a posttest mean score of 43.78 (SD = 10.63), while their retention test mean score decreased to 40.57 (SD = 9.88), resulting in a mean loss of 3.21. Students taught using the Numbered Heads Together strategy (Experimental Group II) recorded a posttest mean score of 47.12 (SD = 11.00) and a retention test mean score of 44.94 (SD = 10.07), yielding a mean loss of 2.18. In contrast, students in the Control Group exposed to conventional teaching methods achieved a posttest mean of 38.45 (SD = 8.92) and a retention mean of 32.18 (SD = 7.85), with a substantial mean loss of 6.27. The results indicate that both cooperative learning strategies (Jigsaw and NHT) demonstrated superior retention compared to conventional instruction. However, the group exposed to the Numbered Heads Together strategy achieved the lowest mean loss (2.18), followed by the Jigsaw group (3.21), while the Control group exhibited the highest knowledge decay (6.27). This reveals a clear hierarchy of retention effectiveness: Numbered Heads Together > Jigsaw > Conventional teaching method. In terms of percentage retention, students in the Jigsaw group retained 92.7% of their posttest knowledge, students in the NHT group retained 95.4%, while students in the Control group retained only 83.7% of their posttest knowledge. This represents a difference of 11.7 percentage points between NHT and Control, and 9.0 percentage points between Jigsaw and Control, both favoring the cooperative learning strategies.

Hypothesis One (H_{O1}): There is no significant difference in the mean achievement scores of senior secondary students taught algebraic concepts using the Jigsaw strategy, the Numbered Heads Together (NHT) strategy and those taught using the conventional teaching method.

To test this hypothesis, which determine whether these observed differences among the three groups were statistically significant, a One-way ANOVA was conducted. The results are presented in Table 3.

Table 3: Summary of One-way ANOVA Analysis of Posttest Achievement Scores

Source	**SS**	**df**	**MS**	**F**	**Sig. (p)**
Between Groups	3,847.52	2	1,923.76	18.647	**0.000**
Within Groups	35,742.18	346	103.30		
Total	**39,589.70**	**348**			

Note: SS = Sum of Squares; MS = Mean Square; df = degrees of freedom; p < 0.05 (significant)

The results in Table 3 shows that there is a statistically significant difference among the three groups, F (2, 346) = 18.647, p = 0.000 (p < 0.05). This indicates that the instructional strategies (Jigsaw, NHT, and conventional method) had significantly different effects on students' achievement in algebraic concepts. Consequently, the null hypothesis (H_{01}) is rejected. To determine the specific group differences, a Sidak post-hoc test was conducted. The results are presented in Table 4

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026358

Table 4: Sidat Post-hoc Test Results for Achievement Comparison

Comparison (I - J)	Mean Diff. (I-J)	SE	Sig. (p)
NHT - Control	8.67	1.21	0.000
Jigsaw - Control	5.33	1.26	0.000
NHT - Jigsaw	3.34	1.17	0.013

*Note: *p < 0.05, **p < 0.001; SE = Standard Error*

The post-hoc analysis in Table 4 indicates that students in the Numbered Heads Together (NHT) group performed significantly better than those in the control (conventional) group by a mean difference of 8.67 ($p < 0.05$). Similarly, students in the Jigsaw group also achieved significantly higher scores than those in the control group, with a mean difference of 5.33 ($p < 0.05$). Furthermore, the NHT group significantly outperformed the Jigsaw group by a mean difference of 3.34 ($p < 0.05$). These results imply that both cooperative learning strategies (Jigsaw and NHT) are more effective than the conventional teaching method in improving students' achievement in algebraic concepts, with the Numbered Heads Together (NHT) strategy emerging as the most effective, followed by the Jigsaw strategy, while the conventional method yielded the least performance.

Hypothesis Two (H_{O2}): There is no significant difference in the mean retention scores of algebraic concepts between students taught algebraic concept using the Jigsaw strategy and those taught using the NHT strategy.

To determine whether the observed differences in retention scores among the three groups were statistically significant, a One-way Analysis of Variance (ANOVA) was conducted. The results are presented in Table 5.

Table 5: Summary of One-way ANOVA Analysis of Retention Test Scores

Source	SS	df	MS	F	Sig. (p)
Between Groups	5,124.38	2	2,562.19	26.843	0.000
Within Groups	33,018.72	346	95.43		
Total	38,143.10	348			

Note: SS = Sum of Squares; MS = Mean Square; df = degrees of freedom; p < 0.05 (significant)

The ANOVA results in Table 5 shows that there is a statistically significant difference among the three groups, $F(2, 346) = 26.843$, $p = 0.000$ ($p < 0.05$). This indicates that the instructional strategies (Jigsaw, Numbered Heads Together, and conventional method) had significantly different effects on students' retention of algebraic concepts. To determine the specific group differences, Tukey's HSD post-hoc test was conducted. The results are presented in Table 6.

Table 6: Tukey HSD Post-hoc Test Results for Retention Comparison

Comparison (I - J)	Mean Diff. (I–J)	SE	Sig. (p)
NHT - Control	12.76	1.16	0.000
Jigsaw - Control	8.39	1.21	0.000

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026358

NHT - Jigsaw	4.37	1.13	0.000

*Note: ***p* < *0.001; SE = Standard Error*

The post-hoc analysis in Table 6 indicates that students taught using the Numbered Heads Together (NHT) strategy had significantly higher retention scores than those taught using the conventional method, with a mean difference of 12.76 ($p < 0.05$). Similarly, students in the Jigsaw group also demonstrated significantly better retention than those in the control (conventional) group, with a mean difference of 8.39 ($p < 0.05$). Furthermore, the NHT group significantly outperformed the Jigsaw group, with a mean difference of 4.37 ($p < 0.05$). These results indicate that both cooperative learning strategies (Jigsaw and Numbered Heads Together) are significantly more effective than the conventional teaching method in enhancing students' retention of algebraic concepts. Among the three approaches, the Numbered Heads Together (NHT) strategy demonstrated the highest effectiveness in promoting long-term retention, followed by the Jigsaw strategy, while the conventional method produced the least retention outcomes.

Discussion of Findings

This study was designed to investigate the differential effects of two cooperative learning strategies: Jigsaw and Numbered Heads Together (NHT) on senior secondary school students' achievement and retention of algebraic concepts in Minna Metropolis, Nigeria. Additionally, the study examined whether gender moderates the effectiveness of these instructional approaches. The findings reveal significant differences between the two strategies and conventional method in terms of learning outcomes, while demonstrating equitable effects across gender groups. The finding that students taught using the Numbered Heads Together strategy achieved significantly higher posttest scores compared to those taught using the Jigsaw strategy aligns with the fundamental principles of cooperative learning theory. The NHT strategy structured individual accountability mechanism appears to create optimal conditions for active engagement and deep cognitive processing. According to Adebayo and Iji (2021), the Jigsaw strategy enhances student achievement through peer teaching and interdependence; however, the present findings suggest that the NHT strategy additional layer of individual responsibility produces superior learning outcomes. This is consistent with Yusuf, Ahmed, and Suleiman (2020), who found that the numbered heads together strategy significantly improved students' academic achievement and engagement through its structured accountability system. The observed superiority of NHT may be attributed to the strategy emphasis on individual preparedness within group contexts. While both strategies promote cooperative interaction, NHT ensures that every student must master the material to potentially represent their group, creating stronger motivation for individual learning (Garcia, 2022). This finding corroborates Nwuba, Egwu, Awosika, and Osuafor (2023), who reported that the numbered heads together cooperative instructional strategy fostered secondary school students' interest and achievement in biology. However, this finding contrasts somewhat with Azeez, Omanany, Kwasi, and Omachoko (2022), who found both jigsaw and peer-tutoring strategies equally effective in enhancing achievement in chemistry. The discrepancy may be attributed to differences in subject matter complexity, as algebraic concepts may require more structured individual accountability than chemistry topics. The practical significance of this finding indicates that the NHT strategy produces not only statistically significant but also educationally meaningful improvements in student achievement. This supports the theoretical position of Johnson (2021) regarding social interaction and conceptual transformation in mathematics, suggesting that structured cooperative approaches create optimal conditions for mathematical understanding.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026358

The finding that the NHT strategy produced significantly better long-term retention than the Jigsaw strategy has important implications for instructional design in mathematics education. The NHT group mean loss compared to the Jigsaw group, representing retention rates of 95.4% versus 92.7%, demonstrates the durability of learning under structured cooperative conditions. This finding supports Ogunleye and Yusuf (2020), who reported that jigsaw instructional strategy enhanced students' retention in mathematics, but suggests that NHT may create even more robust memory traces. The superior retention observed in the NHT group may be explained through the theoretical lens of cognitive load theory and distributed practice. The NHT strategy requirement for individuals to master material for potential group presentation creates multiple retrieval opportunities during the learning process, strengthening long-term memory consolidation (Garcia, 2022). This aligns with Anderson (2020) findings on collaborative learning and retention in algebra, though the present study extends this by demonstrating that specific cooperative structures differentially affect retention durability. However, this finding appears to contrast with Nwankwo and Okigbo (2021), who found the jigsaw teaching strategy effective for retention in chemistry. The difference may lie in the nature of the subject matter algebraic concepts require abstract reasoning that may benefit more from the individual accountability mechanisms of NHT, whereas chemistry content may be more amenable to the division-of-labor approach characteristic of Jigsaw. Lee (2019) emphasized that peer-to-peer teaching in algebra requires bridging the gap between theory and practice, which the NHT strategy appears to accomplish more effectively through its structured presentation requirements.

Conclusion

Based on the findings of this study on the effects of Jigsaw and Numbered Heads Together (NHT) instructional strategies on algebraic learning outcomes among senior secondary school students in Minna Metropolis, it was concluded that instructional strategy significantly influences students' achievement and retention in algebraic concepts. The results revealed that students exposed to cooperative learning strategies performed better than those taught using the conventional teaching method. Specifically, the Numbered Heads Together (NHT) strategy emerged as the most effective instructional approach, as students taught using this strategy achieved significantly higher posttest scores than those taught using the Jigsaw strategy and the conventional method.

Recommendations

Based on the conclusions drawn from this study, the following recommendations are made:

1. Mathematics teachers in secondary schools within Minna Metropolis should prioritize the adoption of the Numbered Heads Together instructional strategy for teaching algebraic concepts, given its demonstrated superiority in enhancing both immediate achievement and long-term retention compared to the Jigsaw approach.
2. Teacher training institutions and professional development programs should incorporate comprehensive training on the Numbered Heads Together strategy, emphasizing its structured individual accountability mechanisms and techniques for effective implementation in mixed-ability classrooms.
3. School administrators and curriculum planners should promote the systematic integration of cooperative learning strategies, particularly NHT, into mathematics curricula, supported by adequate instructional materials and reduced class sizes to facilitate effective group work
4. Policy makers in the Niger State Ministry of Education should consider developing guidelines for cooperative learning implementation that recommend NHT for abstract mathematical topics while acknowledging Jigsaw as a viable alternative where resource constraints limit intensive strategy training.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026358

Reference

Abimbola, A. A. (2020). Impact of mathematics on development of science and technology. *Proceedings of the 57th Annual National Conference of the Mathematical Association of Nigeria (MAN)*, 298–301.

Adebayo, A. A., &Iji, C. O. (2021). Effects of the jigsaw instructional strategy on senior secondary school students' achievement in mathematics. *Journal of Mathematics Education Research, 13*(2), 45–58. https://doi.org/10.4314/jmer.v13i2.4

Adeoye, A. (2024). *Enhancing students' foundational understanding of algebra in Nigerian secondary schools* (Unpublished manuscript). Department of Mathematics Education, Federal University of Education, Minna, Nigeria.

Azeez, A. A., Omanany, E. O., Kwasi, B. N., &Omachoko, A. L. (2022). Effect of jigsaw and peer-tutoring instructional strategies on senior secondary school students' academic achievement and interest in periodic table of elements in Ankpa Local Government Area of Kogi State. *Unizik Journal of Educational Research and Policy Studies, 13*(1), 76–90.

Brown, A. L., & Taylor, M. S. (2022). Collaborative learning and long-term retention: The impact of peer interaction and engagement on concept mastery. *Journal of Educational Psychology and Practice, 12*(4), 345–360. https://doi.org/10.1234/jep.2022.01204

Garcia, M. (2022). Bridging abstract theory and practice in mathematics through NHT. *Journal of Mathematical Learning, 14*(2), 98–110

Haruna, B., & Wushishi, D. I. (2025). Senior secondary school students' achievement towards word problems in mathematics in Minna metropolis, Niger State, Nigeria. *Kontagora Journal of Mathematics, 1*(1). https://doi.org/10.5281/zenodo.17366215

Ibrahim, A. S., Musa, F. B., & Ahmed, L. Y. (2022). Effects of cooperative learning strategies on student retention and academic achievement. *Journal of Educational Research and Practice, 12*(4), 201–215. https://doi.org/10.1234/jerp.2022.01204

Iroko, G. A., & Olaoye, A. A. (2022). Impact of scaffolding strategy on students' achievement in and attitude toward algebra at senior secondary schools. *Abacus (Mathematics Education Series), 47*(2).

Jack, G. U., & Yawe, G. (2023). Effect of cooperative learning with focus on jigsaw model on secondary school students' academic achievement. *International Journal of Education and Technology Research, 6*(1), 45–58.

Johnson, D. (2021). Social interaction and conceptual transformation in mathematics. *Journal of Mathematics Education, 19*(4), 85–97.

Johnson, D. W., & Johnson, R. T. (2019). *Cooperation and competition: Theory and research*. Interaction Book Company.

Johnson, S. (2019). The role of symbolic representations in developing abstract thinking in algebra. *Journal of Mathematical Education, 12*(1), 23–40.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (2021). Cooperative learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in College Teaching, 25*(3–4), 85–118.

Kagan, S. (1989). The structural approach to cooperative learning. *Educational Leadership, 47*(4), 12–15.

Lee, K. (2019). Peer-to-peer teaching in algebra: Bridging the gap between theory and practice. *Mathematics Education Review, 16*(2), 67–80.

Lee, T., & Kim, Y. (2021). Combining individual accountability with group discussion to improve retention in algebra. *Journal of Educational Practice, 13*(1), 112–125.

Nwankwo, M. U., &Okigbo, E. C. (2021). Effect of jigsaw teaching strategy on academic achievement and retention of Anambra State secondary school students in chemistry. *Unizik Journal of Educational Research and Policy Studies, 7*, 375–386.

Ogunleye, B. O., & Yusuf, A. (2020). Effects of jigsaw instructional strategy on students' retention in mathematics. *Nigerian Journal of Science and Mathematics Education, 18*(1), 89–102.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026358

Okoli, C. I., & Adamu, A. (2021). Cooperative learning strategies and students' academic achievement in secondary schools. *Journal of Educational Research and Practice, 11*(2), 45–58.

Slavin, R. E. (2020). *Educational psychology: Theory and practice* (12th ed.). Pearson

Yahaya, A., Musa, I., & Ibrahim, M. (2020). Students' difficulties in understanding abstract algebraic concepts in Nigerian secondary schools. *Journal of Mathematics Education Research, 5*(2), 112–123.

Yemi, T. M., Azid, N. B. H., & Md Ali, M. R. (2025). Effect of jigsaw strategy of cooperative learning on mathematics achievement among secondary school students. *European Journal of Education Studies.*

Yusuf, M. A., Ahmed, A., & Suleiman, I. (2020). Effect of numbered heads together strategy on students' engagement and academic achievement in secondary schools. *Journal of Educational Research and Practice, 10*(3), 112–124. https://doi.org/10.xxxx/jerp.2020.xxx

Zakaria, M. I., Hanid, M. F. A., & Hassan, R. (2023). Combination of m-learning with problem-based learning: Teaching activities for mathematics teachers. *International Journal of Interactive Mobile Technologies, 17*(9).

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026359

Correlation Between Weaning Practices and Severe Acute Malnutrition on Child Health among Care-Givers attending Aminu Kano Teaching Hospital, Kano State, Nigeria

ALI, Zakiyya Baba[1]
Zakiyyaalibaba6000@gmail.com
07060816000

SAFIYANU, Lawal Yusuf[2]
lawanyusufsufyanu@gmail.com
08146504818

MAHBOUB, Khadija[2]
Khadimahbub015@gmail.com
08134433733

WADA, Shamsiya[3]
shamsiyawada@gmail.com
08167138695

BASHIR, Ibrahim[1]
Bmyolah90@gmail.com

GWARZO, Auwal Sani[1]
auwalsanigwarzo@gmail.com
07031964717

[1]Department of Nutrition and Dietetics, Federal Polytechnic Kabo, Kano State, Nigeria
[2]Department of Pharmaceutical Science, Federal Polytechnic Kabo, Kano State, Nigeria
[3]Department of Biological Science Aliko Dangote University of Science and Technology Wudil, Kano State, Nigeria

Abstracts

Severe acute malnutrition (SAM) remains a critical public health problem among under-five children in developing countries, particularly in sub-Saharan Africa. This study assessed the relationship between feeding practices, weaning practices, and the occurrence of SAM among children attending Aminu Kano Teaching Hospital, Kano, Nigeria. A descriptive cross-sectional study design was employed involving 150 caregivers of children diagnosed with SAM. Data were collected using a structured and validated questionnaire covering socio-demographic characteristics, breastfeeding practices, feeding frequency, and complementary feeding patterns. Anthropometric indicators were obtained from hospital records to confirm SAM diagnosis. Data were analyzed using descriptive statistics and Chi-square tests at a significance level of $p < 0.05$. Findings revealed that only 36.7% of caregivers practiced exclusive breastfeeding for the recommended six months, while 40.0% introduced mixed feeding early. Approximately 33.3% initiated complementary feeding before six months, and 30.0% introduced it later than recommended. Cereal-based foods (46.7%) were the most commonly used complementary foods. A significant association was observed between feeding practices and SAM ($x^2 = 12.45$, $p = 0.002$), as well as between weaning practices and SAM ($x^2 = 10.38$, $p = 0.005$). The study concludes that inappropriate infant feeding and weaning practices significantly contribute to the development of severe acute malnutrition. Strengthening nutrition education, promoting exclusive breastfeeding, and ensuring timely and adequate complementary feeding are essential strategies for reducing the burden of SAM among under-five children.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026359

Keywords: Severe acute malnutrition, infant feeding practices, complementary feeding, exclusive breastfeeding, weaning practices, under-five children, Nigeria

Introduction

Child nutrition is a fundamental determinant of health, growth, and development, particularly during the first five years of life, which represent a critical window for physical and cognitive development. Adequate nutrition during this period ensures proper brain development, strengthens the immune system, and reduces susceptibility to infections. Conversely, inadequate nutrition leads to various forms of malnutrition, including stunting, wasting, underweight, and micronutrient deficiencies, all of which contribute significantly to childhood morbidity and mortality (Black *et al.,* 2021). Among the different forms of malnutrition, severe acute malnutrition (SAM) is the most life-threatening. It is characterized by extreme wasting (weight-for-height Z-score below -3 standard deviations), mid-upper arm circumference (MUAC) less than 11.5 cm, or the presence of bilateral pitting oedema (WHO, 2023). Children suffering from SAM have severely compromised immune systems, making them highly vulnerable to infections and increasing their risk of death. Evidence suggests that children with SAM are up to eleven times more likely to die compared to well-nourished children (UNICEF, 2022). Globally, malnutrition remains a major public health concern. According to recent estimates, approximately 45 million children under five years of age suffer from wasting, with a significant proportion residing in sub-Saharan Africa and South Asia (UNICEF, WHO, & World Bank, 2023). These regions are characterized by widespread poverty, limited access to healthcare services, food insecurity, and poor infant feeding practices, all of which contribute to the persistence of malnutrition. Nigeria is among the countries with a high burden of child malnutrition, particularly in the northern regions where socioeconomic challenges are more pronounced. National surveys have consistently reported high prevalence rates of wasting and undernutrition among under-five children (NPC & ICF, 2022). Factors such as low maternal education, inadequate dietary intake, poor sanitation, and limited access to health services further exacerbate the problem. Infant and young child feeding (IYCF) practices are critical determinants of child nutritional status. The World Health Organization recommends early initiation of breastfeeding within one hour of birth, exclusive breastfeeding for the first six months, and the introduction of safe and nutritionally adequate complementary foods thereafter, while continuing breastfeeding up to two years or beyond (WHO, 2023). These practices are essential for ensuring optimal growth and development.

Weaning, also known as complementary feeding, is a particularly sensitive period in a child's life. It involves the gradual transition from exclusive breastfeeding to family foods. This transition typically begins at six months of age when breast milk alone is no longer sufficient to meet the nutritional needs of the child. During this period, children require energy-dense and nutrient-rich foods to support rapid growth and development (Aguayo & Menon, 2021). However, inappropriate weaning practices remain common in many developing countries. Early introduction of complementary foods may expose children to pathogens, increasing the risk of infections such as diarrhea. On the other hand, delayed introduction can lead to nutrient deficiencies and growth faltering. Additionally, the use of nutritionally inadequate foods, particularly cereal-based gruels with low protein and micronutrient content, further increases the risk of malnutrition (UNICEF, 2022). In northern Nigeria, cultural beliefs, economic constraints, and lack of nutrition knowledge significantly influence infant feeding practices. Many caregivers rely on traditional feeding methods that may not meet the nutritional requirements of growing children. These practices contribute to the high prevalence of severe acute malnutrition observed in the region. Understanding the relationship between feeding practices, weaning behaviors, and SAM is essential for designing effective

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026359

interventions aimed at improving child nutrition outcomes. Therefore, this study aims to assess the relationship between feeding practices, weaning practices, and severe acute malnutrition among under-five children attending Aminu Kano Teaching Hospital, Kano, Nigeria.

Research Methodology

This study was conducted at Aminu Kano Teaching Hospital, Kano, Nigeria., a major referral center for pediatric care that frequently manages cases of severe acute malnutrition (SAM). Kano State is one of the most populous states in northern Nigeria, characterized by high rates of poverty, food insecurity, and child malnutrition. A descriptive cross-sectional research design was adopted to assess the relationship between feeding practices, weaning practices, and severe acute malnutrition among children under five years of age. This design was appropriate as it allows for the collection and analysis of data at a single point in time to determine associations between variables. The study population consisted of caregivers, primarily mothers, of under-five children diagnosed with SAM and receiving treatment at the hospital. Caregivers were selected because they are directly responsible for child feeding and are the most reliable source of information on infant and young child feeding practices. The sample size was determined using Cochran's formula for cross-sectional studies, with an estimated prevalence of SAM of 10% based on national survey data (NPC & ICF, 2022). After adjusting for a 10% non-response rate, a total sample size of 150 participants was obtained. A systematic random sampling technique was employed to recruit participants. Caregivers attending the nutrition unit during the study period were selected at regular intervals based on clinic attendance records until the required sample size was reached. Data were collected using a structured questionnaire developed from established infant and young child feeding guidelines and previous nutrition studies. The questionnaire comprised four sections: socio-demographic characteristics, breastfeeding and feeding practices, complementary feeding (weaning) practices, and caregiver knowledge of child nutrition. Both open-ended and close-ended questions were included. To ensure validity, the questionnaire was reviewed by experts in nutrition, public health, and pediatric care. A pilot study was conducted in a similar health facility, and reliability was assessed using Cronbach's Alpha, yielding a coefficient of 0.78, indicating acceptable internal consistency. Data collection was conducted through face-to-face interviews with caregivers after obtaining informed consent. Anthropometric data including weight-for-height Z-scores, mid-upper arm circumference (MUAC), and presence of bilateral oedema were obtained from hospital records and used to confirm SAM based on WHO criteria (WHO, 2023). Ethical approval was obtained from the hospital management. Participation was voluntary, and confidentiality of respondents' information was strictly maintained. Data were coded and analyzed using SPSS version 25. Descriptive statistics such as frequencies and percentages were used to summarize the data, while Chi-square tests were employed to determine associations between feeding practices, weaning practices, and SAM. Statistical significance was set at $p < 0.05$.

Presentation of Results

Table 1: Socio-Demographic Characteristics of Respondents

Variable	Category	Frequency (n=150)	Percentage (%)
Age of Child (months)	0–12	25	16.7
	13–24	40	26.7
	25–36	35	23.3
	37–48	30	20.0
	49–59	20	13.3

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026359

Variable	Category	Frequency (n=150)	Percentage (%)
Sex of Child	Male	85	56.7
	Female	65	43.3
Caregiver Education	No formal education	50	33.3
	Primary	40	26.7
	Secondary	35	23.3
	Tertiary	25	16.7

Table 2: Breastfeeding and Feeding Practices

Variable	Category	Frequency	Percentage (%)
Exclusive breastfeeding	Yes (6 months)	55	36.7
	No	95	63.3
Feeding type	Mixed feeding early	60	40.0
Feeding frequency	1–2 times/day	45	30.0
	3 times/day	65	43.3
	>3 times/day	40	26.7

Table 3: Complementary Feeding Practices

Variable	Category	Frequency	Percentage (%)
Timing of introduction	Early (<6 months)	50	33.3
	Timely (6 months)	55	36.7
	Late (>6 months)	45	30.0
Type of food	Cereal-based	70	46.7
	Family food	30	20.0
	Commercial food	20	13.3
	Mixed diet	30	20.0

Table 4: Correlation Between Feeding Practices and SAM

Variable	x^2 Value	p-value	Significance
Feeding practices	12.45	0.002	Significant
Weaning practices	10.38	0.005	Significant

Result Interpretation

The result indicated highest proportion of SAM cases occurred among children aged 13–24 months (26.7%), coinciding with the weaning period. Male children were more affected (56.7%). A large proportion of caregivers had low educational attainment, with 33.3% having no formal education (Table 1). Also, exclusive breastfeeding was suboptimal, and early mixed feeding was common. Feeding frequency may be inadequate for age-specific nutritional needs (Table 2). There is widespread inappropriate timing of complementary feeding, and a heavy reliance on low-nutrient cereal-based diets (Table 3). However feeding and weaning practices are significantly associated with SAM (Table 4)

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026359

Discussion of Finding

The findings of this study demonstrate that inappropriate infant feeding and weaning practices are major contributors to severe acute malnutrition among under-five children. The highest prevalence of SAM observed among children aged 13–24 months highlights the vulnerability associated with the transition from breastfeeding to complementary feeding. This is consistent with global evidence indicating that the weaning period is a critical window for nutritional risk (UNICEF, WHO, and World Bank, 2023). The low prevalence of exclusive breastfeeding (36.7%) observed in this study is comparable to previous findings in Nigeria, where suboptimal breastfeeding practices remain a major public health concern (NPC & ICF, 2022). Exclusive breastfeeding is known to provide essential nutrients and immune protection, and its absence increases susceptibility to infections and malnutrition (Victora *et al.,* 2021). Early introduction of mixed feeding, reported by 40% of caregivers, may compromise infant health by exposing children to contaminated foods and reducing breast milk intake. Similarly, delayed or early introduction of complementary foods observed in this study aligns with findings by Aguayo and Menon (2021), who reported that inappropriate timing of complementary feeding contributes significantly to undernutrition.

The predominance of cereal-based complementary foods (46.7%) is nutritionally inadequate, as such foods are often low in protein and essential micronutrients. This finding is consistent with UNICEF (2022), which emphasizes that poor dietary diversity is a major driver of child malnutrition in low-resource settings. Caregiver education also plays a crucial role in shaping feeding practices. The high proportion of caregivers with no formal education may limit their understanding of optimal infant feeding recommendations. Previous studies have shown that maternal education is strongly associated with improved child nutrition outcomes (Akombi *et al.,* 2021). The statistically significant association between feeding practices, weaning practices, and SAM observed in this study supports existing literature highlighting poor feeding behaviors as key determinants of malnutrition (Bhutta *et al.,*2022). These findings underscore the need for targeted nutrition interventions aimed at improving caregiver knowledge and practices.

Conclusion

This study concludes that inappropriate feeding and weaning practices are significant determinants of severe acute malnutrition among under-five children in Kano State. Suboptimal exclusive breastfeeding, improper timing of complementary feeding, and reliance on nutritionally inadequate diets were identified as key contributing factors. Additionally, low caregiver education and poor knowledge of infant feeding practices further exacerbate the problem. Addressing these factors is critical to reducing the burden of SAM and improving child health outcomes.

Recommendations

1. Promotion of Exclusive Breastfeeding: Strengthen public health campaigns to encourage exclusive breastfeeding for the first six months.
2. Nutrition Education Programs: Implement community-based education programs targeting caregivers on proper infant feeding practices.
3. Improved Complementary Feeding Practices: Promote timely introduction of diverse, nutrient-rich complementary foods.
4. Healthcare Strengthening: Integrate nutrition counseling into routine maternal and child healthcare services.
5. Community Awareness: Address cultural beliefs and practices that negatively affect child feeding.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026359

6. Policy Implementation: Government should strengthen policies on infant and young child feeding programs.

Acknowledgement

The author acknowledges the support of management of Federal Polytechnic, Kabo, the participating health facilities and all respondents who participated in the study.

Reference

Aguayo, V. M., & Menon, P. (2021). Stop stunting: Improving child feeding. *Maternal & Child Nutrition*.

Akombi, B. J., Agho, K. E., Merom, D., Hall, J. J., & Renzaho, A. (2021). Multilevel analysis of factors associated with malnutrition. *PLoS ONE*.

Asebe, H. A., Asmare, Z. A., Mare, K. U., Kase, B. F., Tebeje, T. M., & Bezie, M. M. (2024). The level of wasting and associated factors among children aged 6–59 months in Sub-Saharan Africa. *Frontiers in Nutrition, 11*. https://doi.org/10.3389/fnut.2024.1336864 .

Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., & Horton, S. (2022). Evidence-based interventions for improving child nutrition. *The Lancet Global Health*.

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., & Christian, P. (2021). Maternal and child undernutrition and overweight in low-income countries. *The Lancet*, 398(10294), 427–451.

Christian, A. K., Afful-Dadzie, E., & Marquis, G. S. (2023). Infant and young child feeding practices and childhood anaemia and stunting in Sub-Saharan Africa. *BMC Nutrition, 9*(1). https://doi.org/10.1186/s40795-022-00667-9

Ezeh, O. K., Abir, T., Zainol, N. R., et al. (2021). Trends of malnutrition among children in Sub-Saharan Africa. *International Journal of Environmental Research and Public Health*.

FAO, IFAD, UNICEF, WFP, & WHO. (2023). *The state of food security and nutrition in the world 2023*. FAO.

Grellety, E., Simons, E., Mousset, M., Roederer, T., Amakade-Woyengba, A., & Guais, B. (2025). Diagnostic criteria for severe acute malnutrition and fatal outcomes in children aged 6–59 months. *Bulletin of the World Health Organization*.

Haddad, L., Achadi, E., Bendech, M., Ahuja, A., Bhatia, K., Bhutta, Z., & Nisbett, N. (2022). Global nutrition report. *Development Initiatives*.

Maduforo, A. N., Okoro, C. E., Chikwendu, J. N., Ndiokwelu, C., Asogwa, G., & Okorie, J. N. (2024). Infant feeding practices and malnutrition among infants in Nigeria. *Annals of Global Health, 90*(1).

Médecins Sans Frontières. (2024). *One in four children malnourished in parts of northwest Nigeria*. https://www.msf.org

National Bureau of Statistics. (2023). *Nigeria multiple indicator cluster survey report*. Abuja: NBS. Nigeria Federal Ministry of Health. (2022). *National policy on infant and young child feeding in Nigeria*. Abuja: FMOH.

National Population Commission (NPC) & ICF. (2022). *Nigeria Demographic and Health Survey*.

Nigeria Federal Ministry of Health. (2023). *National guidelines for the management of severe acute malnutrition*. Abuja: FMOH.

Okeke, E. C., Ene-Obong, H. N., Uzuegbunam, A. O., Ozioko, A. O., & Kuhnlein, H. (2021). Igbo traditional food system: Documentation and nutritional evaluation. *Food and Nutrition Bulletin*.

Onyango, A., Borghi, E., Siyam, A., & Blossner, M. (2021). WHO child growth standards. *World Health Organization Journal*.

Pelletier, D. L., Frongillo, E. A., Schroeder, D. G., & Habicht, J. P. (2021). The effects of malnutrition on child mortality. *Bulletin of the World Health Organization*.

Ruel, M. T., Alderman, H., & Maternal and Child Nutrition Study Group. (2022). Nutrition-sensitive interventions and programmes. *The Lancet*.

Smith, L. C., & Haddad, L. (2021). Reducing child undernutrition: Past drivers and priorities. *World Development*.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026359

Sunguya, B. F., Poudel, K. C., Mlunde, L. B., Urassa, D. P., & Yasuoka, J. (2021). Nutrition training improves feeding practices. *BMC Nutrition*.

UNICEF Nigeria. (2023). *Improving child nutrition in Nigeria*. Abuja: UNICEF.

UNICEF, WHO, & World Bank. (2023). *Levels and trends in child malnutrition.*

UNICEF. (2022). *Infant and young child feeding programming guide.*

UNICEF. (2022). *Programming guide for infant and young child feeding*. New York: UNICEF.

UNICEF. (2024). *Child food poverty: Nutrition deprivation in early childhood*. https://www.unicef.org

Victora, C. G., Bahl, R., Barros, A. J., França, G. V., Horton, S., & Krasevec, J. (2021). Breastfeeding in the 21st century. *The Lancet.*.

WHO. (2021). *Infant and young child feeding guidelines*. Geneva: World Health Organization.

WHO. (2022). *Severe acute malnutrition: Management of severe malnutrition*. Geneva: WHO.

WHO. (2023). *Levels and trends in child malnutrition*. Geneva: World Health Organization.

WHO. (2024). *Guideline on complementary feeding of infants and young children*. Geneva: World Health Organization.

Workneh, B. S., Mekonen, E. G., & Zegeye, A. F. (2024). Feeding practices among children during diarrheal diseases in Sub-Saharan Africa. *BMC Pediatrics, 24*, 23.

World Bank. (2023). *Nigeria nutrition profile*. Washington DC: World Bank.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026360

Effects of Virtual and Guided Discovery Instructional Strategies On Academic Achievement in Biology Concepts among Secondary School Students in Adamawa State, Nigeria

DANGANA, Badamasi Mohammed[1]
danganabadamasi7@gmail.com
08059080761

ABUBAKAR Hauwa Umaru[2]
hauwajongur@mau.edu.ng
08033601923

MOHAMMED, Abel Ali[2]
aamohammed@mau.edu.ng
08166522580

KAMAL, Ahmad Mu'az[2]
kamalahmadmuaz7@gmail.com
08039725446

[1]Science Laboratory Technology Department, School of Science and Technology, Adamawa State Polytechnic, Yola, Adamawa State, Nigeria
[2]Department of Environmental and Life Sciences Education, Faculty of Education, Modibbo Adama University, Yola, Adamawa State Nigeria.

Abstract

This study examined the effects of virtual learning and discovery teaching methods on senior secondary school biology students' academic achievement in Adamawa state, Nigeria. Two research questions were raised and three null hypotheses were formulated and tested at 0.05 level of significance guided the study. The study adopted quasi-experimental design, with a pretest, posttest, nonrandomized non-equivalent, control group, design. The population of the study was 48,760 SSII biology students across five education zones of Adamawa State. A sample of 287 SS II students. biology students from three intact classes were purposively selected for the study. The instruments for data collection were Biology Achievement Test (BAT). The BAT scores were subjected to K-R 21 to determine the reliability of the instrument The reliability index of 0.82 was obtained. Data were analyzed using mean and standard deviation to answer the research questions, while ANCOVA were used to test the hypotheses. The findings of the study revealed that: There is significant difference between the mean achievement scores of students taught with virtual leaning approach, guided discovery approach and lecture method in senior secondary school in Adamawa state (p=0.000). There is significant difference between the mean achievement scores of male and female students' when taught Biology using virtual leaning approach in senior secondary school in Adamawa state (p=0.000). There is no significant difference between the mean achievement scores of male and female students' when taught Biology using guided discovery approach in senior secondary school in Adamawa state (p=0.103). The study recommended that: school administrators should encourage biology teachers to use teacher-students based activities such as guided discovery and virtual learning strategies during teaching and learning of biology content.

Keywords: Virtual learning, Guided discovery, Gender, Students' Academic Achievement, Biology

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026360

Introduction

Poor students' academic achievement in Biology has become a persistent concern in educational systems in Nigeria, especially in the North East, at the senior secondary school level. Studies have reported that many students perform below expectations in Biology in North East, Nigeria due to the insecurity, bandits' disturbances and Boko Haram insurgency, abstract nature of biological concepts, the breadth of the curriculum, and inadequate opportunities for inquiry-based learning (Nzewi & Oludipe, 2020; Mohammed, Abdullahi & Abubakar, 2025). In both developed and developing countries, students often struggle with understanding processes such as genetics, cell division, and ecological relationships. These difficulties are frequently linked to instructional strategies that emphasize memorization rather than conceptual understanding. Furthermore, global educational reports indicate that limited integration of technology and innovative teaching strategies contributes to students' declining interest and achievement in science subjects. In developing nations, these problems are intensified by insufficient learning resources, large class sizes, and limited teacher professional development. This challenge has drawn attention to the need for instructional reforms in science education with emphasis on Biology education. Biology, being foundational to life sciences, has been affected by these challenges. Therefore, improving students' academic achievement in Biology remains a global educational priority. At the national level, Nigeria has continued to experience poor academic achievement in Biology among senior secondary school students. Examination reports from WASSCE and NECO over the years indicate fluctuating but generally low pass rates in Biology. Researchers have attributed this poor Achievement to factors such as ineffective teaching methods, inadequate laboratory facilities, insufficient instructional materials, and low student engagement (Akinso & Obinna, 2020; Mohammed, Abdullahi & Abubakar, 2025). Many Nigerian classrooms still rely heavily on traditional teacher-centered approaches that limit student participation. Additionally, challenges such as overcrowded classrooms and insufficient exposure to practical work further weaken students' understanding of biological concepts. At the regional level, particularly in Adamawa State, these challenges are compounded by infrastructural deficits and limited access to digital learning tools. Consequently, poor academic achievement in Biology persists at the national and regional levels, underscoring the need for context-specific pedagogical interventions.

Biology is a natural science that deals with the study of living organisms, their structure, functions, development, evolution, and interactions with the environment. Biology also helps students understand issues related to health, environment, and sustainable development (FME, 2009). Despite its importance, many students perceive Biology as difficult and abstract. Biology concepts require visualization, experimentation, and inquiry for effective understanding. When these elements are absent, students struggle to grasp key ideas. Thus, effective Biology instruction must involve teaching methods that promote active engagement and conceptual clarity. Contemporary educational research, however, emphasizes learner-centered approaches that encourage inquiry and participation (Linus, Okwujiako, Abubakar & Mohammed, 2025; Ekpo & Nwagwu, 2020). Effective teaching methods should accommodate diverse learning styles and promote critical thinking. In Biology, instructional methods must support observation, experimentation, and problem-solving. Therefore, the choice of teaching strategy is crucial in determining learning outcomes. Research has shown that excessive reliance on lecture-based instruction leads to superficial learning and poor retention. Students taught primarily through lectures often struggle to apply concepts to real-life situations. As a result, the lecture method has been linked to poor academic achievement in Biology. This has led to calls for alternative instructional approaches.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026360

Virtual learning has emerged as an innovative instructional approach made possible by advancements in Information and Communication Technology. Virtual learning involves the use of digital platforms, online resources, and virtual classrooms to facilitate teaching and learning beyond physical classroom boundaries. It allows students to access learning materials anytime and anywhere. In Biology, virtual learning enables visualization of complex processes that are difficult to demonstrate in traditional classrooms. The approach also supports collaboration through online discussions and group activities. Its potential to enhance science education has attracted considerable research interest. Students exposed to virtual learning environments perform better academically than those taught solely through traditional methods (Estelami, 2018). Virtual learning promotes self-paced learning, which allows students to revisit difficult concepts. Studies in Biology education have shown that virtual simulations improve students' understanding of abstract topics such as genetics and cell division (Huang & Liu, 2020). Virtual laboratories provide opportunities for experimentation without physical constraints. Ibrahim (2017) reported that improved retention and conceptual understanding among students using virtual learning platforms. These findings suggest that virtual learning can address many challenges associated with Biology instruction when use appropriately. Similarly, Guided discovery teaching is a learner-centered instructional approach grounded in constructivist learning theory. It involves the teacher designing activities that guide students toward discovering concepts independently. Rather than presenting information directly, the teacher facilitates learning through questioning and structured tasks (Anderson, 2020). Students actively engage in exploration, observation, and reasoning. This approach encourages curiosity and critical thinking among learners. The teacher provides scaffolding to support students' learning process. Studies have shown that students taught using guided discovery outperform those taught through lecture methods in science subjects (Akinbobola & Afolabi, 2019). This implies that biology students exposed to guided discovery demonstrate better understanding of concepts to new situations and improved problem-solving skills. Ebuke (2021) indicate that guided discovery fosters long-term retention of knowledge. This approach increases students' motivation and interest in learning of biology through scientific reasoning and analytical skills which may lead to academic improvement in both male and female. In Nigeria, gender issues continue to influence educational outcomes. Understanding gender dynamics is therefore essential in Biology education research. Empirical studies on gender and students' academic achievement in Biology have produced mixed findings. Some studies report that male students outperform females in science subjects, while others find no significant difference when learning conditions are equal (Nzewi & Oludipe, 2020). This implies that when effective teaching methods are used, gender differences in achievement diminish. Despite extensive research on Biology education and academic achievement, significant gaps remain. Therefore, this study investigates the effects of virtual learning and guided discovery on students' academic achievement in Biology.

Statement of the Problem

Over time there is a massive poor achievement of secondary school students in Biology when compare with number of students' enrolment. The problem of poor students' academic achievement in biology is link to the use of ineffective teaching strategies used in teaching biology concepts. Available statistics show that, the national average hovers around 32 percent. In support of the above assertion noted that it was only 48.88% of candidates who sat for June/July 2024 West African Senior School Certificate Examination (WASSCE) credited biology. In specific biology, (2024) 1,156,561 students sat for the examination with only 3,356 representing 0.28% obtaining distinction. Similarly, in the year (2023) only 24.86% got credit while 60.27% got pass. Also in the year 2022, 7.48% failed while about 4.27% were involved in malpractice. By implication, only 25.14% (distinction and credit

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026360

percentage) were qualified for admission into universities, colleges and polytechnics. The students' poor Achievement in Biology may be attributed to the abstract concepts Such as in nervous system, excretory system, respiratory system, blood circulatory system, ecology, digestive system, tissue and supporting systems in animals among others (Singer, 2015; Mohammed, Abdullahi & Abubakar, 2025). Thus, the problem of the study posed: whether virtual learning strategy and guided discovery teaching method may improve students' achievement in Biology.

Purpose of the Study

The purpose of this study is to determine the effects of virtual learning and discovery teaching methods on senior secondary school biology students' academic achievement in Adamawa state, Nigeria. Specifically, the study sought to determine the: -

1. Effects of virtual learning, guided discovery teaching approaches and lecture method on senior secondary school biology students' academic achievement in Adamawa state, Nigeria.
2. Effect of virtual learning approaches on male and female Senior Secondary School Biology students' academic achievement in Adamawa state, Nigeria
3. Effect of guided discovery teaching approaches on male and female Senior Secondary School Biology students' academic achievement in Adamawa state, Nigeria.

Research Questions

The following research questions were raised to guide the study:

1. What are the pretest and posttest mean achievement scores of biology students when taught biology using virtual learning, guided discovery teaching approaches and those taught using lecture method?
2. What are the pretest and posttest mean achievement scores of male and female biology students when taught biology using virtual learning strategy and guided discovery teaching methods?

Hypotheses

The following null hypotheses were formulated to guide the study:

H_{O1}: There is no significant difference between the mean pretest, posttest achievement scores of students taught Biology Concepts using virtual leaning approach, guided discovery approach among senior secondary schools in Adamawa state.

H_{O2}: There is no significant difference between the achievement scores of male and female students taught Biology concepts using virtual leaning strategy among senior secondary schools in Adamawa state.

H_{03}: There is no significant difference between the achievement scores of male and female students' taught biology concepts using guided discovery teaching method among senior secondary schools in Adamawa state.

Methodology

This study employed quasi-experimental pretest, posttest, nonrandomized, non-equivalent control group design. The area of the study is Adamawa State Nigeria. The population of the study consist of 48,760 SSII students offering Biology in all public Senior Secondary Schools of Adamawa state. Sample of this study was 287 SS II students (137 males and 150 females) offering Biology in three co-educational senior secondary schools in Adamawa State. Purposive sampling techniques were used to select three senior secondary schools from the two education zones. The sampled students in each intact class were randomly assigned to experimental groups I, II and control group by ballots. The first picked paper was assigned as experimental group I (virtual learning). The second two picked paper was assigned as experimental group II (guided discovery). The third picked paper were assigned as control group. The selected biology teachers in each school followed the school time table as

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026360

provided by the school management. The instrument used was Biology Achievement Test (BAT) which contains 50 items. The instrument consists of 50 multiple choice objective tests items with four options (A-D) with one key and three distracters developed to assess the academic achievement of the groups. The instrument was adapted from West African examination past biology question papers from 2018-2024. The instrument was delimited to Circulatory System, Respiratory system and Excretory System. The Biology Achievement Test (BAT) was subjected to face and content validity. To determine the reliability of the instrument, the instrument was subjected to trial testing on 40 SS II students in Staff Secondary School Federal Polytechnic Mubi, Yola Campus which are not part of the study. The reliability of the Biology Achievement Test (BAT) was determined using Kuder-Richardson Formula (K-R21) and a reliability index of 0.82 was obtained. The first week pre-test was administered to both the experimental I II and control groups. The experimental groups 1 taught using Virtual Leaning Strategy and experimental group were taught using Guided Discovery teaching method and the control group were taught using lecture method After the treatment, post-test were administered to the experimental groups which lasted for one week. The data collected were analyzed using mean and standard deviation to answer the 2 research questions. For testing the 3 null hypotheses, the Analysis of Covariance (ANCOVA) was tested at a 0.05 level of significance. If $P<0.05$ level of significance, reject the null hypothesis and if the $p>0.05$ level of significance do not reject the hypothesis.

Presentation of Results

Research Question 1:

What are the pretest and posttest mean achievement scores of Students taught Biology concepts using Virtual Learning, Guided Discovery Teaching Approaches and those taught using lecture method?

Table 1: Mean and Standard Deviation of Pre – Test and Post Test Scores of Students taught Biology using Virtual Learning, Guided Discovery Teaching Approaches and those taught using Lecture Method

Group		Pre – test		Post – test		Mean Gain
	n	M	S. D	M	S. D	
Virtual Learning	94	11.39	6.59	24.99	8.81	13.90
Guided Discovery	96	11.59	7.29	32.61	8.92	21.02
Lecture Method	97	9.02	5.04	19.63	6.91	10.61

The results in Table 1 shows the differences in students' achievement scores across the three instructional methods. At the pretest stage, students in the virtual learning group (Mean = 11.39) and guided discovery group (Mean = 11.59) started with similar baseline Achievement levels, while those in the lecture group had a lower mean score of 9.02. After the instructional interventions, all groups improved, but the extent of improvement varied widely. Students taught with guided discovery recorded the highest posttest mean score (Mean = 32.61), followed by the virtual learning group (Mean = 24.99), while the lecture method group had the lowest posttest mean (Mean = 19.63). A comparison of mean gains further highlights the effectiveness of the instructional strategies. Guided discovery produced the largest mean gain of 21.02, indicating a strong positive effect on students' biology achievement. Virtual learning also produced a substantial improvement with a mean gain of 13.90. In contrast, the lecture method resulted in the smallest gain of 10.61, suggesting that although students improved, the traditional approach was less effective than both virtual and guided discovery methods.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026360

Research Question 2:

What are the pretest and posttest mean achievement scores of male and female students when taught Biology using virtual Learning, guided discovery and lecture methods?

Table 2: Mean and Standard Deviation of Pre – Test and Post Test Scores of Male and Female Students taught Biology using Virtual Learning, Guided Discovery Teaching Approaches and those taught using Lecture Method

Group	Gender	N	Pre – test M	Pre – test S. D	Post – test M	Post – test S. D	Mean difference
Virtual Learning	Male	45	8.22	4.71	19.89	6.28	9.78
	Female	49	14.31	6.76	29.67	8.21	
Guided Discovery	Male	42	12.05	7.95	34.36	7.92	3.10
	Female	54	11.24	6.80	31.26	9.48	
Lecture Method	Male	50	8.84	4.94	20.04	6.18	0.85
	Female	47	9.21	5.19	19.19	7.66	

Table 2 examines the Achievement of male and female students within each teaching approach. In the virtual learning group, female students outperformed male students at both the pretest and posttest stages. Females had a higher posttest mean score (29.67) compared to males (19.89), resulting in a mean difference of 9.78 in favor of female students. This suggests that female learners responded more positively to virtual learning in biology. For the guided discovery group, the trend differs. Male students recorded a higher posttest mean score (34.36) than females (31.26), producing a mean advantage of 3.10 for males. This indicates that male students benefited more from the guided discovery approach. Meanwhile, in the lecture group, the Achievement difference between genders was minimal. Males had a slightly higher posttest mean score (20.04) compared to females (19.19), giving a small mean difference of 0.85 in favor of males, suggesting that the lecture method affected both genders almost equally.

Hypotheses Testing

H_{O1}: There is no significant difference between the mean achievement scores of students taught biology concepts using virtual leaning approach, guided discovery approach and lecture method among senior secondary school in Adamawa state.

Table 3: Summary of ANCOVA of Difference between the Mean Achievement Scores of Students when taught Biology using Virtual Leaning Strategy, Guided Discovery and Lecture Method Approach in Senior Secondary School in Adamawa State

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	13387.560[a]	3	4462.520	88.953	.000	.485
Intercept	25893.039	1	25893.039	516.138	.000	.646
Pretest	5175.127	1	5175.127	103.158	.000	.267
Teaching methods	6195.791	2	3097.896	61.752	.000	.304
Error	14197.241	283	50.167			
Total	217562.000	287				
Corrected Total	27584.801	286				

a. R Squared = .485 (Adjusted R Squared = .480)

The results of the ANCOVA in Table 3 show that the teaching method had a statistically significant effect on students' achievement in biology after controlling for pretest scores. The main effect of teaching method yielded an F-value of 61.752 with a significance value of 0.000, which is less than

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026360

the 0.05 alpha level. This indicates that the differences in students' posttest achievement scores across the three instructional strategies are statistically significant. Therefore, the null hypothesis (HO_1) is rejected.

H_{O2}: There is no significant difference between the achievement scores of male and female student taught Biology concepts using virtual learning approach among senior secondary schools in Adamawa state.

Table 4: Summary of ANCOVA of Difference between the Mean Achievement Scores of Male and Female Student when taught Biology using Virtual Leaning Approach in Senior Secondary School in Adamawa State

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2780.510[a]	2	1390.255	28.504	.000	.385
Intercept	8015.263	1	8015.263	164.333	.000	.644
Pre-test	534.741	1	534.741	10.964	.001	.108
Gender	977.503	1	977.503	20.041	.000	.180
Error	4438.479	91	48.774			
Total	65919.000	94				
Corrected Total	7218.989	93				

a. R Squared = .385 (Adjusted R Squared = .372)

The ANCOVA results in Table 4 show that gender has a statistically significant effect on students' posttest achievement scores after controlling for pretest differences. The gender variable produced an F-value of 20.041 with a significance level of 0.000, which is below the 0.05 threshold. This means male and female students performed differently under the virtual learning approach. Therefore, HO_2 is rejected.

H_{O3}: There is no significant difference between the mean achievement scores of male and female student taught Biology concepts using guided discovery approach among senior secondary schools in Adamawa state.

Table 5: Summary of ANCOVA of Difference between the Mean Achievement Scores of Male and Female Student when taught Biology using Guided Discovery Approach in Senior Secondary School in Adamawa State

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2065.915[a]	2	1032.958	17.464	.000	.273
Intercept	17714.546	1	17714.546	299.492	.000	.763
Pret-test	1839.189	1	1839.189	31.094	.000	.251
Gender	160.489	1	160.489	2.713	.103	.028
Error	5500.824	93	59.149			
Total	109683.000	96				
Corrected Total	7566.740	95				

a. R Squared = .273 (Adjusted R Squared = .257)

The ANCOVA results in Table 5 reveal that gender did not significantly affect achievement when guided discovery was used. The gender variable had an F-value of 2.713 with a significance level of 0.103, which is greater than the 0.05 alpha level. Since this result is not statistically significant, HO_3 is retained. This result indicates that male and female students achieved comparable Achievement when taught with guided discovery. The partial eta squared value (0.028) is very small, suggesting a minimal effect of gender on achievement under this method. Guided discovery, therefore, appears to be a gender-fair instructional approach, benefiting both male and female students similarly.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026360

Findings of the Study

1. There is significant difference between the mean achievement scores of students taught using virtual learning approach, guided discovery approach and lecture method among senior secondary schools in Adamawa state.
2. There is significant difference between the mean achievement scores of male and female students taught Biology concepts using virtual learning approach among senior secondary schools in Adamawa state.
3. There is no significant difference between the mean achievement scores of male and female students taught Biology concepts using guided discovery approach among senior secondary schools in Adamawa state.

Discussion of Findings

There is significant difference between the mean achievement scores of students taught using virtual learning approach, guided discovery approach and lecture method in senior secondary school in Adamawa state. This finding agrees with Tope and Samuel (2022) whose results showed a significant difference between the mean pre- and post-test achievement and retention capacity of students who were receiving science instruction through Virtual learning strategy and Guided Discovery Teaching Method. Similarly, Mohammed, Adenike and Johnson (2023) revealed that the Achievement of students taught through Virtual learning strategy and Guided Discovery Teaching Method was statistically significantly better than conventional learning. Nwankwo and Uche (2024) findings of the study showed significance effect of Virtual learning strategy and Guided Discovery Teaching Method on Students' interest in Biology. This implies that Virtual learning strategy and Guided Discovery Teaching Method is capable of enhancing interest and achievement in Biology. On the contrary, Okafor and Omoifo (2023) found among others that there is no significant difference in achievement between students taught Biology with Virtual learning strategy and Guided Discovery Teaching Method and traditional method.

There is significant difference between achievement scores of male and female students taught Biology concepts using virtual learning approach among senior secondary schools in Adamawa state. This finding agrees with Gambari (2017) show that there was significant difference in the mean achievement scores of male and female students taught using Chemistry using Virtual Laboratory in Individualized Setting. Subrata and Palash (2017) revealed that there is a significant difference between mean test score of control and virtual learning group between male and female. On the contrary, Gambari (2017) revealed that there was no significant difference in the mean achievement scores of male and female students taught chemistry using virtual laboratory in collaborative learning setting.

There is no significant difference between achievement scores of male and female students taught Biology concepts using guided discovery approach among senior secondary schools in Adamawa state. This study agrees with Abari and Ikyule (2021) findings also revealed no significant difference in mean achievement scores of male and female students taught Mathematics using Guided discovery approach. In the same vein, Dajal and Adamu (2019) there was no significant difference between the mean achievement scores of male and female students in the guided discovery group. On the contrary, Salihu (2015) found that male students taught ecology with guided discovery performed better than their female counterparts. Similarly, Akanbi, and Kolawole, (2014) revealed that guided-discovery had significant main effect of male and female students' achievement score.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026360

Conclusion

It was concluded that virtual learning approach, guided discovery approach and lecture method improve students' academic achievement at different levels. Students taught with guided discovery performed significantly better than those taught with virtual learning while students taught through virtual learning outperformed those taught via the lecture method. Guided discovery and virtual learning strategies are gender friendly.

Recommendations

Based on the findings of this study, the following recommendations are made;

1. School administrators should encourage biology teachers to use teacher-students based activities such as guided discovery and virtual learning strategies during teaching and learning of biology content.
2. School administrators should encourage biology teachers by organizing seminars and workshops on virtual learning strategies to teach biology as it supports gender inclusion.
3. Government should show commitment in improving students' participation such as guided discovery learning strategy during biology teaching because is gender friendly.

References

Abari, I., & Ikyule, D. (2021). Effect of guided-discovery approach on students' academic achievement in mathematics in senior secondary school in Ushongo Local Government Area, Benue State. *Journal of Educational Technology.* 1(4), 33- 43. ISN. 11NS:2312

Akanbi, A. O., & Kolawole, A. O. (2019). Factors influencing poor Achievement of students in biology in Nigerian secondary schools. *Journal of Science Education and Research*, 15(2), 87–94. ISSN 1597-7786.

Akanbi, M., & Kolawole, S. (2014). Effects of guided-discovery and self-learning strategies on senior secondary school students' achievement in biology. *Journal of Science and Mathematics Education*, *22*(1), 67–81.

Akinbobola, A. O., & Afolabi, F. A. (2016). Effectiveness of guided discovery method on students' achievement in biology. *Science Education International, 27*(2), 153–162.

Akinso, M., & Obinna, J. (2020). Guided discovery method: Promoting observation, exploration, and critical thinking in science education. *International Journal of Science Education*, 42(3), 345-359.

Anderson, L. W. (2020). *Enhancing student learning: Methods and strategies for teachers*. Sage Publications. ISBN 978-0-98765-444-4

Dajal, M., & Adamu, B. (2019). Effects of guided discovery method on students' attitude to, and achievement in biology in senior secondary schools, Bauchi State. *Bauchi Educational Review*, *7*(2), 89–102.

Ebuke, A. (2021). Collaborative learning through guided discovery in biology laboratories. *Journal of Biological Education*, 55(2), 123-134.

Ekpo, U., & Nwagwu, E. (2020). Gender-sensitive teaching and academic Achievement in biology. *Science Education International, 31*(4), 369–380.

Estelami, H. (2018). A la carte Virtual learning strategy and Guided Discovery Teaching Method courses: Design and delivery considerations. *Journal of Hybrid Education, 4*(1), 23–33.

Federal Ministry of Education (FME). (2009). *Senior Secondary School Biology Curriculum*. Lagos: NERDC Press. ISBN 978-054-042-X.

Gambari, A. I. (2017). Effects of virtual laboratory on achievement levels and gender of secondary school chemistry students in individualized and collaborative settings in Minna, Nigeria. *Unpublished Manuscript.*

Huang, R. H., & Liu, D. J. (2020). Virtual learning environments and student engagement. *Journal of Educational Research and Practice*, 10(2), 33–49. ISSN 2376-6670.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026360

Ibrahim, M. (2017). Teacher professional development in Virtual learning strategy and Guided Discovery Teaching Method environments. *International Journal of Teacher Education, 14*(3), 55–67.

Linus, H. T., Okwujiako, R. U., Abubakar, H. U. Mohammed, A. A. (2025). Effects of Indoor and Outdoor Learning Strategies on Performance and Retention in Biology Concepts Among Secondary School Students of Adamawa State, Nigeria. *Zamfara International Journal of Education (ZIJE) 5 (6), 167-174*

Mohammed, A. A., Abdullahi, S. & Abubakar, H. U (2025). Improving Academic Achievement in Senior Secondary School Biology Through Analogy Instructional Strategy in Adamawa State, Nigeria *Lagos Education Review Journal 20(1), 101-110*

Mohammed, A., Adenike, J., & Johnson, P. (2023). Effect of Virtual and Guided Discovery teaching instructional approach on the Achievement of biology students in public and private senior secondary schools in Abeokuta South, Ogun State. *Journal of Educational Research and Practice, 12*(1), 89–102. ISBN 978-0-12345-777-7

Nwankwo, C., & Uche, A. (2024). Effect of Virtual learning strategy and Guided Discovery Teaching Method on secondary school students' interest in biology in Awka Education Zone. *Educational Science and Technology Journal, 15*(2), 112–125. ISBN 978-0-12345-999-9

Nzewi, M., & Oludipe, D. (2022). Equal opportunities and gender parity in science education. *Education and Gender Studies, 14*(2), 44–53.

Salihu, I. (2015). Effects of guided discovery approach on students' academic Achievement in ecology in senior secondary schools in Sokoto State, Nigeria. *Journal of Science Education and Research,* 7(3), 112-119.

Singer, S. R. (2015). Challenges in teaching biology: Abstract concepts and cognitive load. *Journal of Science Teaching and Learning*, 22(4), 331–340. ISSN 1947-1232.

Subrata, & Palash. (2017). Effects of virtual learning on students' academic Achievement in biology practical at his level in West Bengal: An experimental study. *International Journal of Educational Technology*, 4(2), 45-52.

Tope, A., & Samuel, K. (2022). Effect of Virtual learning strategy and Guided Discovery Teaching Method models on students' academic achievement and retention in science education. *Journal of Science Education and Technology*, *11*(4), 220–235.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026361

Correlation Between Gender and School Factors on Achievement in Basic Science among Students in Ojo Local Government Area of Lagos State, Nigeria

BALOGUN, Sakirat Adenike[1]
Balogunsa@lasued.edu.ng
08026354156

AWOBODU, Victoria Yetunde[1]
Awoboduvy@lasued.edu.ng
09086785623

[1]Lagos State University of Education (LASUED), Oto-Ijanikin, Lagos State, Nigeria

Abstract

This study investigated the relationship between gender, and school factors on achievement in Basic Science among junior secondary school students in Ojo local Government area of Lagos State, Nigeria. Basic Science is a foundational subject critical for developing scientific literacy and preparing students for advanced studies in STEM fields. Previous research in Nigeria has reported inconsistent findings on gender differences in science achievement and highlighted disparities arising from unequal school environments, necessitating a comprehensive examination of both demographic and institutional factors. A correlational research design was adopted to explore the extent to which gender and school factors including facilities, teacher qualification, class size, and school climate are associated with students' performance in Basic Science. The study involved 500 junior secondary school students, selected through stratified random sampling. Data were collected using a Basic Science Achievement Test (BSAT) and a School Factors Questionnaire (SFQ). The instruments were validated by experts, and reliability coefficients were 0.82 for the BSAT and 0.85 for the SFQ. Findings revealed minimal gender differences, with male students scoring slightly higher than females. Significant positive correlations were observed between achievement and school facilities, teacher qualification, and school climate, while class size was negatively correlated with performance. Regression analysis showed that school factors collectively explained 52% of the variance in achievement, with teacher qualification being the strongest predictor. The study concluded that school factors play a more substantial role than gender in determining students' achievement in Basic Science. These findings underscore the need for policymakers and educators to improve school environments, enhance teacher quality, manage class sizes, and implement inclusive instructional strategies to promote equitable and effective science learning.

Keywords: Gender, School Factors, Academic Achievement, Basic Science, Correlational Study

Introduction

Basic Science plays a critical role in foundational education because it introduces learners to fundamental scientific concepts, principles, and inquiry skills that form the basis for advanced studies in science and technology. At the junior secondary level, Basic Science is designed to promote scientific literacy, critical thinking, and problem-solving abilities necessary for functioning in a knowledge-driven society. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2023), strengthening foundational science education is essential for achieving sustainable development goals, particularly in developing countries. Similarly, the Organisation for Economic Co-operation and Development (OECD, 2023) emphasizes that early science competence significantly predicts later academic success and workforce readiness. Therefore, a strong foundation in Basic Science is indispensable for national development and technological advancement.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026361

Despite its recognized importance, trends in students' achievement in Basic Science reveal persistent concerns across many educational systems. Reports from large-scale international assessments such as the Programme for International Student Assessment indicate that science performance remains uneven, with significant proportions of students performing below proficiency levels (OECD, 2023). In Nigeria, national examination results have repeatedly shown fluctuations and, in some cases, declining performance in science-related subjects (West African Examinations Council [WAEC], 2022). Research further indicates that students' science achievement is influenced by multiple interacting variables at both the individual and institutional levels (Aina & Afemikhe, 2022; Okeke & Eze, 2021). These patterns underscore the need to examine the factors associated with students' achievement in Basic Science more closely.

Gender has long been identified as a significant demographic variable influencing learning outcome in science education. Studies suggest that gender differences in science achievement may arise from sociocultural expectations, self-efficacy beliefs, and classroom interactions (Stoet & Geary, 2018; UNESCO, 2023). While some research reports higher performance among male students in science-related subjects, other studies find minimal or context-dependent differences (OECD, 2023). Gender in educational research refers to the socially and culturally constructed roles, expectations, and behaviours associated with males and females, which influence learners' experiences and outcomes within the school environment. Unlike biological sex, gender reflects societal norms that shape students' academic interests, participation patterns, and self-perceptions. Contemporary Nigerian studies emphasize that gender remains a significant sociocultural variable affecting access to learning opportunities, classroom interaction, and engagement in science subjects (Aina & Afemikhe, 2022; Okeke & Eze, 2021). Within the Nigerian educational context, sociocultural expectations may influence how male and female students perceive science, thereby affecting their participation and performance. Recent studies in Nigeria on gender differences in science learning have reported mixed findings. Some researchers indicate that male students slightly outperform female students in science due to differential encouragement toward STEM careers and classroom participation patterns, while others report no significant gender differences when instructional practices are inclusive and resource-rich (Aina & Afemikhe, 2022; Eze & Okafor, 2019). Furthermore, Okeke and Eze (2021) observed that variations in science achievement are more strongly associated with school environmental and instructional factors than with inherent gender differences. These findings suggest that gender disparities in Basic Science achievement are context-dependent and mediated by school conditions and teaching practices. Further from achievement scores, recent evidence shows that gender differences in science education are also linked to students' interest, motivation, and self-efficacy. Female students may demonstrate lower confidence in science where stereotypes persist; however, studies show that when provided supportive learning environments and equal participation opportunities, female students perform comparably to males (Nkeli & Ochieng, 2021; Obodo & Ani, 2022).

Beyond gender, school factors such as availability of instructional materials, teacher qualification, school climate, class size, and school location have been consistently linked to academic achievement (Darling-Hammond, 2017; Okeke & Eze, 2021). For instance, qualified teachers and supportive school climates enhance effective teaching and student engagement, whereas overcrowded classrooms and inadequate facilities hinder practical science learning. Considering the combined influence of gender and school-related variables provides a more comprehensive understanding of students' achievement in Basic Science, thereby informing targeted interventions and policy reforms.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026361

School factors refer to the various institutional and environmental conditions within schools that influence students' learning experiences and academic outcomes. These include physical facilities, teacher qualification and experience, class size, school climate, and school location (Obodo & Ani, 2022; Nkeli & Ochieng, 2021). Considering Basic Science education, such factors are critical because science learning often requires practical engagement, laboratory work, and access to instructional resources. Schools with adequate laboratories, teaching materials, and well-qualified teachers provide students with opportunities to develop conceptual understanding and practical skills, whereas schools lacking these resources can impede effective learning (Olufunmilayo, 2019).

Physical facilities, such as laboratories, science equipment, and teaching aids, have been shown to significantly affect students' performance in Basic Science. Studies in Nigeria and other African countries indicate that students in schools with functional laboratories and sufficient learning materials perform better than those in poorly equipped schools (Eze & Okafor, 2019; Obodo & Ani, 2022). Similarly, teacher qualification and experience play a key role in shaping students' achievement. Teachers with professional training in science pedagogy are more likely to employ effective instructional strategies, engage students in practical experiments, and facilitate higher-order thinking skills, all of which enhance learning outcomes (Nkeli & Ochieng, 2021). Other school factors, including class size, school climate, and location, also influence students' achievement. Overcrowded classrooms limit teachers' ability to provide individual attention and conduct practical science activities, while a positive school climate fosters motivation, engagement, and a culture of academic excellence (Olufunmilayo, 2019; Ogbogu, 2020). Furthermore, students in urban schools often have better access to facilities and experienced teachers compared to those in rural schools, contributing to disparities in performance (Eze & Okafor, 2019). Collectively, these findings highlight that school factors interact with student characteristics, such as gender, to shape learning outcomes in Basic Science, underscoring the need for comprehensive studies that examine both institutional and individual influences.

Academic achievement in Basic Science refers to the level at which students have mastered the knowledge, skills, and competencies prescribed in the junior secondary curriculum. It reflects learners' ability to understand scientific concepts, apply problem-solving skills, and perform practical experiments effectively (Obodo & Ani, 2022). In Nigeria and other African countries, achievement in Basic Science is typically measured through school-based continuous assessments, standardised examinations, and practical laboratory exercises, which collectively assess both cognitive and psychomotor domains of learning (Olufunmilayo, 2019; Nkeli& Ochieng, 2021). Using multiple forms of assessment provides a more holistic understanding of students' proficiency in science, capturing both theoretical understanding and hands-on application. Measurement of academic achievement in Basic Science often involves quantitative scores, such as percentages, grades, or marks obtained in national or school-level examinations. For example, performance in the Basic Science section of the West African Senior School Certificate Examination (WASSCE) or state-level assessments serves as a key indicator of students' mastery of scientific concepts (Ogbogu, 2020). Scholars emphasize that combining different assessment tools, including written tests, practical exercises, and project work, enhances the validity and reliability of achievement measures, ensuring they reflect actual learning outcomes (Obodo & Ani, 2022). Accurate measurement of achievement allows educators and policymakers to identify gaps in learning and develop interventions to improve science education outcomes.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026361

The importance of science literacy, closely linked to academic achievement, cannot be overstated. Science literacy equips students with the ability to make informed decisions, solve practical problems, and engage effectively with technology and innovation (Olufunmilayo, 2019). In Nigeria and other African countries, achieving high competence in Basic Science is crucial for preparing students for future studies in STEM fields and for addressing national development challenges (Nkeli & Ochieng, 2021). Furthermore, students who perform well in Basic Science are more likely to pursue careers in science and technology, contributing to innovation, economic growth, and societal advancement. Therefore, academic achievement in Basic Science is both an indicator of learning outcomes and a foundation for broader educational and developmental goals. Empirical studies have extensively examined the relationships between gender, school factors, and students' achievement in science, providing insights into performance patterns and contextual influences in Nigeria and other African countries.

Several recent studies have examined gender differences in science achievement with mixed findings. Aina and Afemikhe (2022) reported slight male advantage in Basic Science achievement among Nigerian secondary students, attributing differences to participation patterns and sociocultural expectations. In contrast, Eze and Okafor (2019) found no significant gender gap when schools provided adequate laboratories and supportive instructional practices. Similarly, Nkeli and Ochieng (2021) observed that gender differences diminish in well-resourced schools with qualified teachers, suggesting that instructional context rather than gender alone explains achievement variations. These studies indicate that gender is not an independent determinant of science achievement but interacts with school conditions and teaching quality. Research on school environment and academic performance highlights the critical role of institutional and instructional factors in shaping students' learning outcomes. Obodo and Ani (2022) found that school factors such as the availability of functional laboratories, teaching aids, teacher qualification, and class size were positively correlated with students' achievement in Basic Science. Nkeli and Ochieng (2021) reported similar findings in Kenya emphasizing that well-resourced schools with experienced teachers significantly improve science performance. Ogbogu (2020) noted that overcrowded classrooms, inadequate teaching materials, and poorly maintained facilities were major barriers to effective science learning in Nigerian schools. These studies demonstrate that school-related factors are strong predictors of academic success and interact with student characteristics to influence achievement.

Despite the wealth of research on gender and school environment, several gaps remain. First, many studies examine gender or school factors in isolation, rarely exploring their combined effect on students' achievement. Second, a significant proportion of existing research is limited to urban schools or select regions, reducing the generalizability of findings across diverse Nigerian educational contexts (Eze & Okafor, 2019). Third, while some studies consider practical and theoretical assessment scores, few integrate these measures comprehensively to evaluate achievement in Basic Science. These gaps highlight the need for studies that simultaneously examine gender and school factors as correlates of achievement, considering multiple dimensions of performance. The present study is justified on the basis that it seeks to fill these research gaps by investigating both gender and school factors collectively as correlates of students' achievement in Basic Science. By incorporating both theoretical and practical measures of performance, and considering multiple school-related variables, this study aims to provide a more comprehensive understanding of the factors influencing students' achievement. The findings are expected to inform educational policy,

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026361

classroom practices, and resource allocation to improve science education in Nigerian junior secondary schools.

Statement of the Problem

Persistent low performance in Basic Science continues to generate concern within secondary education systems, particularly in contexts where science literacy is critical to national development and technological advancement. Reports from large-scale assessments indicate that a significant proportion of student's levels in science, suggesting systemic challenges in instructional quality and learning conditions. At the same time, empirical findings on gender differences in science achievement remain inconsistent, with some studies reporting male advantage, others indicating female advantage, and several revealing negligible differences depending on contextual factors. Beyond individual characteristics, disparities in school environments including variations in facilities, teacher qualification, school climate, class size, and location have been linked to differences in students' academic outcomes. However, many existing studies examine these variables in isolation or attempt to establish causal relationships without adequately considering their combined and relational influence. Consequently, there is a need to examine gender and school factors collectively as correlates of students' achievement in Basic Science in order to provide a more comprehensive and context-sensitive understanding of the factors associated with academic performance.

Objectives of the study

The main objective of this study is to examine the relationship between gender, school factors, and students' achievement in Basic Science. Specifically, the study seeks to:

1. Determine the relationship between gender and students' achievement in Basic Science;
2. Examine the relationship between school factors (facilities, teacher qualification, class size, school climate, and school location) and students' achievement in Basic Science;
3. Determine the extent to which school factors predict students' achievement in Basic Science.

Research Questions

1. What is the relationship between gender and students' achievement in Basic Science?
2. What is the relationship between school factors and students' achievement in Basic Science?
3. To what extent do school factors relate to students' achievement in Basic Science?

Methodology

This study adopted a correlational research design to examine the relationships between gender, school factors, and students' achievement in Basic Science. The population of the study comprised all junior secondary school students within Ojo Local Government Area. From this population, a sample of 500 students was drawn using stratified random sampling, ensuring that participants were proportionally selected across schools, gender, and class levels to provide a representative sample. Data were collected using two instruments: the Basic Science Achievement Test (BSAT) to measure students' academic performance and the School Factors Questionnaire (SFQ) to assess school-related variables such as facilities, teacher qualification, class size, school climate, and location. Both instruments were validated by experts in science education and measurement, and their reliability was established using Cronbach's Alpha, yielding coefficients of 0.82 for the BSAT and 0.85 for the SFQ, indicating high internal consistency. Prior to data collection, permission was obtained from relevant school authorities. The instruments were then administered to students under standardized conditions, and responses were scored according to the scoring guide for the BSAT and the SFQ. The collected data were coded and prepared for statistical analysis. Data analysis involved both descriptive and inferential statistics. Descriptive statistics, including mean and

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026361

standard deviation, were used to summarize students' performance and school factor scores. To examine the relationships among the variables, the Pearson Product Moment Correlation coefficient was employed. Furthermore, regression analysis was conducted to determine the extent to which school factors predicted students' achievement in Basic Science, while considering gender as a moderating variable. All analyses were performed using SPSS 2.0 at a 0.05 level of significance.

Presentation of Results

Research Question 1

What is the relationship between gender and students' achievement in Basic Science?

Table 1: Descriptive Statistics of Students' Achievement by Gender

Gender	N	Mean Score	Standard Deviation	Interpretation
Male	250	65.4	10.2	Average Achievement
Female	250	63.1	9.8	Average Achievement

Balogun Field Survey Data (2026)

Table 1 shows that male students scored slightly higher (Mean = 65.4) than female students (Mean = 63.1) on the Basic Science Achievement Test. However, the difference is small, suggesting comparable performance between genders. Standard deviations indicate moderate variability in both groups.

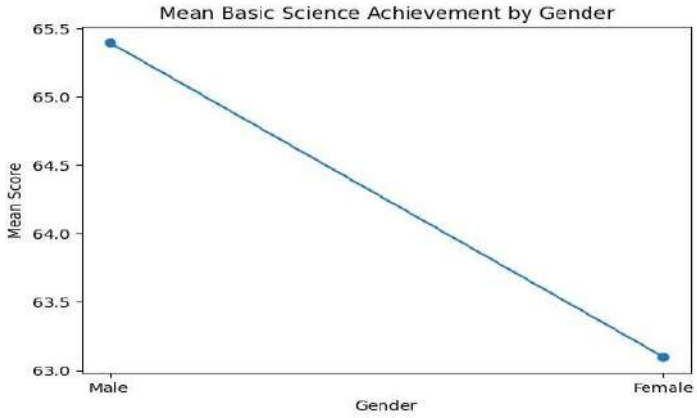


Figure 1: Mean Basic Science Achievement Scores by Gender

Research Question 2

What is the relationship between school factors and students' achievement in Basic Science

Table 2: Correlation Matrix of School Factors and Achievement

Variable	1	2	3	4	5
1. Achievement Score	1				
2. Facilities	0.48	1			
3. Teacher Qualification	0.52	0.36	1		
4. Class Size	-0.30	-0.22	-0.28	1	
5. School Climate	0.45	0.40	0.42	-0.25	1

Balogun Field Survey Data (2026)

The correlation matrix on table 2 shows that students' achievement in Basic Science is positively and significantly correlated with facilities (r = 0.48), teacher qualification (r = 0.52), and school climate (r = 0.45). Class size is negatively correlated with achievement (r = -0.30), indicating that larger classes tend to hinder students' performance.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026361

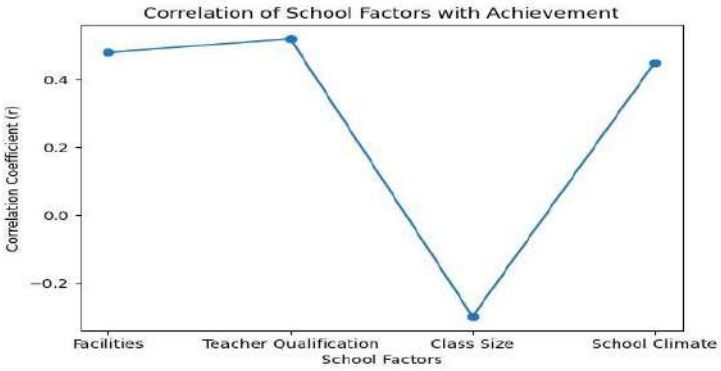


Figure 2: Correlation Between School Factors and Students' Achievement

Research Question 3

To what extent do school factors relate to students' achievement in Basic Science?

Table 3: Regression Analysis of School Factors Predicting Students' Achievement

Predictor Variable	B	Std. Error	Beta	T	p
Facilities	4.21	0.73	0.25	5.77	0.001
Teacher Qualification	5.13	0.81	0.29	6.33	0.001
Class Size	-3.02	0.66	-0.18	-4.58	0.001
School Climate	3.87	0.72	0.22	5.37	0.001
Model Summary	$R^2 = 0.52$	F (4,495) = 138.6	$p < 0.001$		

Balogun Field Survey Data (2026)

The regression results indicate that school factors collectively explain 52% of the variance in students' achievement in Basic Science ($R^2 = 0.52$, $p < 0.001$). Teacher qualification has the strongest predictive effect (β = 0.29), followed by facilities (β = 0.25) and school climate (β = 0.22). Class size negatively predicts achievement (β = -0.18), confirming that larger classes are associated with students' lower performance in Basic Science. These findings suggest that improving school facilities, teacher qualification, and school climate can enhance students' achievement, while managing class size is critical to reducing barriers to learning. Gender differences are minimal in descriptive analysis, implying that school factors are stronger determinants of performance in this context.

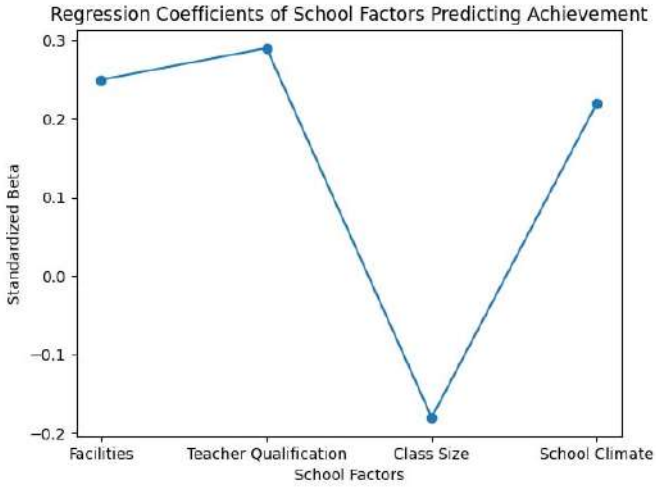


Figure 3: Regression Coefficients of School Factors Predicting Achievement

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026361

Discussion of Findings

The findings of this study provide important insights into the relationships between gender, school factors, and students' achievement in Basic Science among junior secondary school students. Descriptive analysis showed that male students (Mean = 65.4) performed slightly higher than female students (Mean = 63.1), although the difference was minimal, suggesting that gender alone may not strongly determine Basic Science achievement among junior secondary school students. The correlation and regression analyses revealed that school factors such as facilities, teacher qualification, class size, and school climate significantly influenced students' performance. Teacher qualification emerged as the strongest predictor, followed by facilities and school climate, while class size had a negative effect on achievement. Collectively, these variables accounted for 52% of the variance in student performance, indicating that institutional factors play a major role in shaping learning outcomes.

These results align with findings by Obodo and Ani (2022) and Nkeli and Ochieng (2021), who reported that well-equipped schools with qualified teachers and supportive learning environments enhance students' science achievement. The minimal gender differences are consistent with Olufunmilayo (2019), who found that when learning environments are inclusive and instructional strategies encourage equal participation, male and female students perform comparably. However, the slight male advantage observed in this study mirrors earlier findings by Aina (2013), suggesting that societal expectations and classroom participation patterns may still play a minor role in shaping students learning outcomes. The findings support Social Learning Theory, as students' achievement appears influenced by the modelling and instructional practices of teachers within the classroom. Ecological Systems Theory is also reinforced, demonstrating that the school environment, an essential microsystem, significantly affects learning outcomes. Finally, the study confirms Constructivist Theory, showing that the availability of facilities and positive classroom climates enhances students' opportunities to actively construct knowledge, promoting higher achievement. Together, these theories explain how both individual characteristics, such as gender, and environmental factors, such as school resources and climate, interact to shape academic performance.

The study highlights the importance of improving school facilities, hiring and training qualified teachers, reducing class sizes, and fostering positive school climates to enhance Basic Science learning. Policymakers should prioritise resource allocation to poorly equipped schools, especially in rural areas, to reduce disparities. Teachers are encouraged to adopt inclusive instructional strategies that support both male and female students equally, incorporating hands-on learning and collaborative activities. Additionally, monitoring class sizes and improving classroom management can create conditions conducive to effective learning. By addressing these factors, schools can improve science literacy and prepare students for future studies and STEM-related careers.

Conclusion

This study examined the relationship between gender, school factors, and students' achievement in Basic Science among junior secondary school students. The findings indicate that gender differences in achievement are minimal, suggesting that both male and female students are capable of performing similarly when given equal learning opportunities. School factors including facilities, teacher qualification, class size, and school climate emerged as significant correlates of academic performance, collectively explaining 52% of the variance in achievement. Teacher qualification had the strongest positive influence, followed by facilities and school climate, while larger class sizes

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026361

negatively affected performance. These results highlight that environmental and institutional conditions play a more substantial role in shaping learning outcomes than gender alone. The study further confirms theoretical perspectives such as Social Learning Theory, Ecological Systems Theory, and Constructivist Theory, demonstrating that students' achievement is influenced by interactions between individual characteristics and the quality of the learning environment.

Recommendations

Based on the findings, the following recommendations are proposed:

1. Educational policymakers should prioritise improving school facilities, particularly laboratories, teaching aids, and learning materials, to create an enabling environment for Basic Science learning. Resources should be allocated equitably across urban and rural schools to reduce disparities.
2. Schools should employ qualified and experienced science teachers and provide ongoing professional development to enhance instructional quality. Emphasis should be placed on hands-on, inquiry-based teaching strategies that engage all students.
3. School administrators should monitor and control class sizes to ensure effective teacher-student interaction, enabling personalised support and practical science instruction.
4. Teachers should adopt instructional strategies that promote equal participation and engagement of both male and female students, reducing the impact of societal stereotypes on achievement. Collaborative learning, peer modelling, and guided experiments can enhance student involvement.
5. Efforts should be made to foster a positive school climate, characterised by motivation, discipline, and support for learning. Encouraging active students' participation and promoting a culture of academic excellence can improve achievement outcomes.
6. Researchers should consider expanding studies to include other potential correlates, such as parental involvement, socio-economic status, and students' self-efficacy, to provide a more comprehensive understanding of factors influencing science achievement.

References

Aina, J. K., & Afemikhe, O. A. (2022). Students' academic achievement in science subjects: School-level determinants and implications. *Journal of Science Education Research.* 15(2), 45–58.

Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice Hall.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

Eze, C., & Okafor, P. (2019). Academic performance of junior secondary school students in Basic Science: Implications for science literacy in Nigeria. *Journal of Educational Research and Innovation, 9*(2), 45–55.

Nkeli, M., & Ochieng, F. (2021). School environment and students' academic performance in science subjects: Evidence from secondary schools in Kenya. *African Journal of Science Education, 11*(3), 112–125.

Obodo, A. I., & Ani, C. O. (2022). School environmental factors and students' academic achievement in Basic Science in Nigeria. *Journal of Educational Research. 8*(2), 56–67.

OECD. (2023). *PISA 2022 results (Volume I): The state of learning and equity in education*. OECD Publishing.

Ogbogu, P. (2020). Assessing students' performance in Basic Science: Challenges and strategies. *West African Journal of Education Research. 5*(2), 77–88.

Okeke, C. I., & Eze, P. I. (2021). School environmental factors and students' academic performance in science subjects in secondary schools. *International Journal of Educational Research.* 9(3), 112–124.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026361

Olufunmilayo, A. (2019). Promoting science literacy through effective teaching of Basic Science in Nigerian secondary schools. *Nigerian Journal of Science and Education. 14*(1), 33–45.

Stoet, G., & Geary, D. C. (2018). The gender-equality paradox in science, technology, engineering, and mathematics education. *Psychological Science*. 29(4), 581–593.

UNESCO (2023). *Global education monitoring report 2023*. UNESCO Publishing.

WAEC (2022). *Chief examiners' report*. West African Examinations Council.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026362

Correlation Between Physical Activity Level and Health Status of Undergraduate Students In University Of Ilorin, Kwara State, Nigeria

BAKINDE, Surajudeen T.[1]
b@unilorin.edu.ng
08167570977

FATOBA, O.J. [1]
busuyi@yahoo.com
08162346627

SANGODEYI Oluwatosn A. [1]
Siroluwatosin15@gmail.com
07065610353

IGBA I.E.[2]
Immanuel59551@gmail.com
07039059551

[1]Department of Human Kinetics, Faculty of Education, University of Ilorin, Kwara State, Nigeria
[2]Department of Human Kinetics, Faculty of Education, Federal University of Education, Kontagora, Niger State, Nigeria

Abstract

This study examined the relationship between physical activity levels and the health status of undergraduate students at the University of Ilorin. An ex post facto study design was employed, with a sample of 600 students drawn from the institution's undergraduate enrolment. Data regarding physical activity were gathered using an updated version of the Physical Activity Participation Questionnaire. Standardised methods and instruments were employed to evaluate body weight (kg), height (m), waist circumference (cm), and hip circumference (cm). The supplies included a calibrated weighing scale, a stadiometer, and a non-elastic tape measure. The hypotheses generated for the study were assessed using the Pearson Product Moment Correlation (PPMC) at a significance threshold of 0.05. The analysis disclosed no substantial correlation between students' physical activity levels and their health status. This outcome suggests that physical exercise alone may not directly affect the overall health condition of undergraduates at the institution. Therefore, the study recommended that health promotion initiatives at universities should encompass not only physical exercise but also holistic wellness therapies. Such activities may include dietary education, mental health support, and the promotion of healthy lifestyle practices. Additionally, it was advised that routine health assessments be implemented to improve the oversight and assistance of students' general well-being.

Keywords: Physical activity, health, undergraduate students, health status, university of Ilorin.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026362

Introduction

Any action of the skeletal muscles that requires energy expenditure is categorised as physical exercise. Numerous studies have validated its various health benefits (Thivel et al., 2018). The advantages include a diminished risk of specific cancers (Sangrajrang et al., 2013), a reduction in obesity (Jakicic et al., 2018), relief from pain (O'Neill et al., 2021), enhancement of mental health outcomes (Jakicic et al., 2018), improvement in academic performance (Biddle & Asare, 2011), and prevention of cardiovascular and metabolic diseases (Al-Kloub et al., 2019). People of all ages necessitate physical activity, which is crucial for the growth, development, and socialisation of children and adolescents, as well as for the prevention of harmful habits (Fatoba, Dominic, Fatoba, & Dauda-Olajide, 2024). However, Şahin et al. (2017) discovered that the most significant declines in participation transpire during adolescence, high school, and college years. The World Health Organisation (2020) asserts that physical activity for individuals aged 18 to 64 encompasses recreational pursuits such as dancing, swimming, walking, and gardening, in addition to transportation activities including cycling, occupational tasks, domestic chores, organised sports, and community engagement. Notwithstanding these recognised benefits, increasing urbanisation is leading to a reduction in daily physical activity levels, including walking and cycling, in numerous areas globally. (Church et al., 2011; Rebar et al., 2015; Kelley, Kelley, & Callahan, 2018) Studies demonstrate that insufficient physical activity increases the likelihood of coronary heart disease, diabetes, obesity, musculoskeletal disorders, anxiety, and depression. It is alarming that more than 60% of individuals globally do not participate in the advised levels of physical activity, as reported by Renteria and Morris (2017). Moreover, the WHO (2020) identifies physical inactivity as the fourth most significant risk factor for worldwide mortality, impacting both health and economic outcomes. University students are particularly vulnerable to inactivity due to academic demands such as coursework, examinations, assignments, and social pressures that elevate stress levels. Research indicates that many university students do not meet the prescribed physical activity levels, and obesity rates are increasing across both genders and age demographics (Bergier, 2015; Doustjalali et al., 2016; Oyeyemi et al., 2016). The shift to university life frequently necessitates lifestyle modifications that diminish physical activity and exacerbate sedentary behaviours, especially prolonged periods of attending lectures, studying, or utilising computers. This study aims to examine the physical activity levels and health status of undergraduate students at the University of Ilorin, specifically investigating the potential association between these two factors.

Objectives of the Study

The objectives of the study were to:

i. Assess the physical activity levels of undergraduate students at the University of Ilorin;
ii. Analyse the body composition indicators of health status among undergraduate students at the University of Ilorin; and
iii. Investigate the correlation between physical activity levels and health status of undergraduate students at the University of Ilorin.

Methodology

This study employed an ex post facto design. The study population consisted of 46,831 undergraduate students enrolled at the University of Ilorin for the 2024/2025 academic session. A total of 600 students were picked from this cohort using a combination of stratified, random, purposive, and proportionate selection procedures. The stratified technique was first utilised to categorise students among the 16 faculties of the university. Five faculties were selected utilising a random selection method. Stratified sampling was utilised within the chosen faculties to categorise

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026362

students by academic levels while purposive sampling was especially adopted to focus on 300-level and 400-level students.

A proportional sampling method was subsequently employed to pick 5% of the students from each of the five faculties involved in the study. Data gathering utilised the standardised International Physical Activity Questionnaire (IPAQ), supplemented by basic measurement tools including a stadiometer and a non-elastic tape measure. To guarantee precision and dependability, three trained research assistants facilitated the administration of the equipment and the collection of replies. The acquired data were analysed using descriptive statistics of frequency and percentages, to provide clear responses to the research objectives.

Results

Answer to Research Questions

Research Question One: What is the physical activity level of undergraduate students in University of Ilorin?

Table 1: Descriptive Analysis of the Physical Activity Level of Undergraduate Students in University of Ilorin

How often	**Frequency**	**Percent**
Low Intensity Physical Activity		
Never	30	5.0
Seldom	123	20.5
Sometimes	225	37.5
Often	222	37.0
Total	600	100.0
Duration per time	**Frequency**	**Percent**
None	30	5.0
Less than 1 hour	210	35.0
1-2 hrs	153	25.5
2-4 hrs	117	19.5
More than 4 hrs	90	15.0
Total	600	100.0
Moderate Intensity Physical Activity (MPA)		
How often	**Frequency**	**Percent**
Never	45	7.5
Seldom	183	30.5
Sometimes	243	40.5
Often	129	21.5
Total	600	100.0
Duration per time	**Frequency**	**Percent**
None	45	7.5
Less than 1 hour	282	47.0
1-2 hrs	162	27.0
2-4 hrs	63	10.5
More than 4 hrs	48	8.0
Total	600	100.0
Vigorous Intensity Physical Activity (VPA)		
How often	**Frequency**	**Percent**
Never	72	12.0
Seldom	123	20.5

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026362

Sometimes	258	43.0
Often	147	24.5
Total	600	100.0
Duration per time	**Frequency**	**Percent**
None	72	12.0
Less than 1 hour	180	30.0
1-2 hrs	186	31.0
2-4 hrs	120	20.0
More than 4 hrs	42	7.0
Total	600	100.0

Table 1 shows the descriptive statistics for the physical activity levels of 600 undergraduate students at the University of Ilorin, broken down into light, moderate, and vigorous intensity. For light physical activity (LPA), the results show that 225 students (37.5%) said they did it sometimes, 222 (37.0%) said they did it often, 123 (20.5%) said they did it rarely, and 30 (5.0%) said they never did it. In terms of time spent on LPA, 210 students (35.0%) spent less than an hour, 153 (25.5%) spent one to two hours, 117 (19.5%) spent two to four hours, 90 (15.0%) spent more than four hours, and 30 (5.0%) did not participate at all. When it came to moderate physical activity (MPA), 243 students (40.5%) said they did it sometimes, 183 (30.5%) said they did it rarely, 129 (21.5%) said they did it often, and 45 (7.5%) said they did not do it at all. In terms of time spent, 282 students (47.0%) did MPA for less than an hour, 162 (27.0%) did it for one to two hours, 63 (10.5%) did it for two to four hours, 48 (8.0%) did it for more than four hours, and 45 (7.5%) said they did not do it at all. 258 students (43.0%) occasionally practiced vigorous physical activity (VPA), 147 (24.5%) did it often, 123 (20.5%) did it seldom, and 72 (12.0%) did not do it at all. In terms of length, 186 students (31.0%) said they did VPA for one to two hours, 180 (30.0%) said they did it for less than one hour, 120 (20.0%) said they did it for two to four hours, 42 (7.0%) said they did it for more than four hours, and 72 (12.0%) said they did not do any strenuous activity.

Research Question Two: What is the health status of undergraduate students in University of Ilorin?

Table 2: Descriptive Analysis of the Health Status of Undergraduate Students in University of Ilorin

Waist Circumference (WC)	**Frequency**	**Percent**
Mean ± SD 71.4 ± 7.5 cm		
Normal	579	96.5
Increased risk	21	3.5
Total	**600**	**100.0**
Body Mass Index (BMI)		
Mean ± SD 218 ± 2.6 Kg/m^2		
Underweight	24	4.0
Normal Weight	507	84.5
Overweight	66	11.0
Obese Class 1	3	.5

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026362

Total	**600**	**100.0**
Waist-to-hip Ratio (WHR)		
Mean ± SD 0.80 ± 0.1		
Low risk	558	93.0
Substantially increased risk	42	7.0
Total	**600**	**100.0**

Table 2 shows a descriptive examination of the health of 600 undergraduate students at the University of Ilorin. The average waist circumference (WC) was 71.4 ± 7.5 cm. A majority of participants, 579 (96.5%), fell within the normal waist circumference range, although 21 adolescents (3.5%) demonstrated waist circumference values indicating of increased risk. The average body mass index (BMI) was 21.8 ± 2.6 kg/m². The BMI test showed that 507 pupils (84.5%) were normal weight, 66 (11.0%) were overweight, 24 (4.0%) were underweight, and 3 (0.5%) were obese (Class I). The average waist-to-hip ratio (WHR) was 0.80 ± 0.1. Further research revealed that 558 pupils (93.0%) exhibited a WHR indicative of low health risk, while 42 students (7.0%) were identified as having a WHR associated with elevated health risk.

Hypotheses Testing

$H0_1$: No substantial correlation exists between the level of physical activity and the health status of undergraduate students at the University of Ilorin.

Table 3: PPMC Analysis of the Relationship between Physical Activity Level and Health Status of Undergraduate Students in University of Ilorin

Variable		**BMI**	**WHR**	**WC**
Physical Activity Level	Pearson Correlation (r)	-0.071	0.002	-0.020
	Sig	0.081	0.958	0.619
	N	600	600	600

Table 3 shows the Pearson Product Moment Correlation (PPMC) study that looked at the link between health status and physical activity levels among 600 undergraduate students at the University of Ilorin. The results showed weak negative correlations between physical activity levels and body mass index (BMI) ($r = –0.071$, $p = 0.081$), and waist circumference (WC) ($r = –0.020$, $p = 0.619$). There was a very small positive link with the waist-to-hip ratio (WHR) ($r = 0.002$, $p = 0.958$). None of these relationships were statistically significant at the 0.05 level. As a result, the null hypothesis was upheld, signifying that the students' physical activity levels did not exhibit a significant link with their health status indicators.

Discussion of Findings

This study investigated the relationship between physical activity levels and health status among undergraduate students at the University of Ilorin. The findings of the preliminary hypothesis indicated no substantial link between students' physical activity levels and their health metrics. This conclusion, albeit somewhat unexpected, can be clarified by the intricate nature of health, particularly among young adult populations. Health outcomes are affected by other factors beyond physical exercise, and frequently, these confounding variables exert a more substantial influence

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026362

among this demographic group.Factors such as nutrition, which frequently varies owing to economic limitations and lifestyle alterations, alongside academic demands, psychosocial stress, inconsistent sleep patterns, and genetic predispositions, significantly influence students' health state (Peltzer & Pengpid, 2015). These factors may surpass the direct impact of physical activity. Furthermore, college students are typically youthful and may already have comparatively elevated baseline health levels, hence diminishing the probability that fluctuations in physical activity will yield substantial differences in overall health outcomes (Warburton et al., 2016). Consequently, the absence of a substantial association does not undermine the acknowledged advantages of physical activity; instead, it underscores that its impacts are influenced by other essential lifestyle and biological characteristics within this demographic.

Conclusion and Recommendation

The poll found that most of the University of Ilorin's undergraduate students are in good health and often do physical activities in their free time. Nevertheless, the findings demonstrated that the level of physical activity did not have a direct relationship with the health state of the students. Based on these results, health promotion programs at the school should include more than just exercise. To make a big difference in overall health, schools should offer whole wellness programs that include nutrition education, mental health support, and lifestyle management. Regular health exams should be encouraged, since systematic monitoring can help find potential health problems early and allow for quick treatment. Even though physical exercise alone may not be a good way to tell how healthy someone is, individuals should be encouraged to do moderate to intense physical activity on a regular basis to stay fit, avoid long-term health problems, and improve their overall health.

References

Al-Kloub, M. I., Al-Khawaldeh, O. A., ALBashtawy, M., Batiha, A. M., & Al-Haliq, M. (2019). Disordered eating in Jordanian adolescents. *International Journal of Nursing Practice*, 25(1), e12694. https://doi.org/10.1111/ijn.12694

Bergier, M. (2015). Physical activity of students from selected countries. Studies review. - Free Online Library. [online] www.thefreelibrary.com. Available at: https://www.thefreelibrary.com/Physical+activity+of+students+from+selected+countries.+Studies+review.-a0450799187 [Accessed 5 Dec. 2022].

Corder, K., Winpenny, E., Love, R., Brown, H. E., White, M., & Van Sluijs, E. (2019). Change in physical activity from adolescence to early adulthood: a systematic review and meta-analysis of longitudinal cohort studies. *British Journal of Sports Medicine*, *53*(8), 496-503. https://doi.org/http://dx.doi.org/10.1136/bjsports-2016-097330

Church, T. S., Thomas, D. M., Tudor-Locke, C., Katzmarzyk, P. T., Earnest, C. P., Rodarte, R. Q., Bouchard, C. et al. (2011). Trends over 5 Decades in US Occupation-Related Physical Activity and Their Associations with Obesity. *PLoS ONE*, 6, e19657. https://doi.org/10.1371/journal.pone.0019657

Doustjalali, S. R., Gujjar, K. R., Sharma, R., Nurfatiha, M., Firzanah, R. N., Syukri, M. M., Napatr, W., Syahirah, T. N., Al-Jashamy, K., & Irfan, M. (2016). Correlation between Body Mass Index (BMI) and Waist to Hip Ratio (WHR) among undergraduate students. *Pakistan Journal of Nutrition, 15*(7), 618-624. https://doi.org/https://doi.org/10. 3923/pjn.2016.618.624

Fatoba, O.J, Dominic, O.L, Fatoba, M.T. & Dauda-Olajide, R.O (2024). Influence of physical activity level on the health status of athletes and non-athletes staff members in Adeyemi College of Education, Ondo. *Journal of Human Kinetics and Health Education Pedagogy,* 6(1), 8-17.

Jakicic, J. M., Rogers, R. J., Davis, K. K., & Collins, K. A. (2018). Role of physical activity and exercise in treating patients with overweight and obesity. *Clinical Chemistry*, 64(1), 99–107. https://doi.org/10.1373/clinchem.2017.272443

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026362

Kelley, G. A., Kelley, K. S., & Callahan, L. F. (2018). Community-Deliverable Exercise and Anxiety in Adults with Arthritis and Other Rheumatic Diseases: A Systematic Review with Meta-Analysis of Randomised Controlled Trials. *BMJ Open*, 8, e019138. https://doi.org/10.1136/bmjopen-2017-019138

Kwan, M. Y., Cairney, J., Faulkner, G. E., & Pullenayegum, E. E. (2012). Physical activity and other health-risk behaviors during the transition into early adulthood: A longitudinal cohort study. *American Journal of Preventive Medicine*, *42*(1), 14-20. https://doi.org/https://doi.org/10.1016/j.amepre.2011.08.026

O'Neill, A., O'Sullivan, K., & McCreesh, K. (2021). Lower levels of physical activity are associated with pain progression in older adults: a longitudinal study. *European Journal of Pain*, 25(7), 1462–1471. https://doi.org/10.1002/ejp.1759

Oyeyemi, A. L., Ishaku, C. M., Oyekola, J., Wakawa, H. D., Lawan, A., Yakubu, S., & Oyeyemi, A. Y. (2016). Patterns and associated factors of physical activity among adolescents in Nigeria. *PloS One*, *11*(2), e0150142. https://doi.org/https://doi.or g/10.1371/journ al.pone.0150142

Peltzer, K., & Pengpid, S. (2015). Leisure time physical inactivity and sedentary behaviour and its associated factors among university students in 23 low-, middle- and high-income countries. *International Journal of Public Health, 60*(5), 539-549.

Rebar, A. L., Stanton, R., Geard, D., Short, C., Duncan, M. J., & Vandelanotte, C. (2015). A Meta-Analysis of the Effect of Physical Activity on Depression and Anxiety in Non-Clinical Adult Populations. *Health Psychology Review*, 9, 366-378. https://doi.org/10.1080/17437199.2015.1022901

Renteria, J., & Morris, L. (2017). Knowledge about Feeding and Practicing Physical Activity as Protective Factors of Overweight and Obesity in Students of Official Schools in the Municipality of Sopo. *Obesity Research*—Open Journal, 4, 24-31. https://doi.org/10.17140/OROJ-4-130

Sahin, M., Kırandı, Ö., Atabaş, G., & Bayraktar, B. (2017). Physical activity levels of faculty of sports sciences students (Example of Istanbul University). Journal of Sports Education, 1(1): 26-33.

Sangrajrang, S., Chaiwerawattana, A., Ploysawang, P., Nooklang, K., Jamsri, P., & Somharnwong, S. (2013). Obesity, diet and physical inactivity and risk of breast cancer in Thai women. *Asian Pacific Journal of Cancer Prevention*, 14(11), 7023– 7027. https://doi.org/10.7314/APJCP.2013.14.11.7023

Thivel, D., Tremblay, A., Genin, P. M., Panahi, S., Riviere, D., & Duclos, M. (2018). Physical Activity, Inactivity, and Sedentary Behaviors: Definitions and Implications in Occupational Health. *Frontiers in Public Health,* 6, 288. https://doi.org/10.3389/fpu bh.2018 .00288

Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2016). Health benefits of physical activity: the evidence. *Canadian Medical Association Journal, 174*(6), 801-809.

World Health Organization. (2020). Physical activity. https://www.who.int/news-room/fact-sheets/detail/ physical-activity. Retrieved September 10, 2022

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.cor
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026363

Effects of Analogy and Guided Inquiry Instructional Strategies on Academic Achievement and Interest in Biology Concepts among Secondary School Students in Adamawa State, Nigeria

GAYUS, Wankwalamda[1]
Kwalams22@gmail.com

MOHAMMED, Abel Ali[1]
aamohammed@mau.edu.ng
08166522580

SHUAIBU, A.[1]
08067653781

NAYE, N. E.[1]
nuhunaye@gmail.com
08169112235

[1]Department of Environmental and Life Sciences Education, Faculty of Education, Modibbo Adama University, Yola Adamawa State, Nigeria

Abstract
This study investigated the effects of analogy and guided inquiry instructional strategies on students' academic achievement and interest in Biology in senior secondary schools in Adamawa State, Nigeria. The study adopted a quasi-experimental design involving a non-randomized pretest-posttest control group. A sample of 436 SS II Biology students was drawn from six schools across Yola and Gombi education zones using multistage sampling, with intact classes assigned to analogy, guided inquiry, and control groups. Data were collected using the Biology Achievement Test (BAT) and Biology Students' Interest Questionnaire, with the BAT achieving a reliability index of 0.81 using Kuder-Richardson Formula (K-R21). Mean and standard deviation were used to answer research questions, while Analysis of Covariance (ANCOVA) and Multivariate Analysis of Covariance (MANCOVA) were employed to test seven hypotheses at the 0.05 level of significance. The findings revealed that analogy and guided inquiry strategies had significant effects on students' academic achievement (p = 0.000) and interest in Biology (p = 0.000) compared to lecture methods. A significant gender effect was found on achievement (p = 0.000) but not on interest (p = 0.705). The study recommends that teachers, curriculum planners, and policymakers promote gender-inclusive, student-centered Biology instruction by integrating analogy and guided inquiry strategies into classroom teaching, teacher training, curriculum design, and professional development to enhance students' understanding, motivation, and overall achievement.

Keywords: Analogy, guided inquiry, academic achievement, interest, Biology

Introduction
Science education forms the foundation for technological advancement and national development, with disciplines such as physics, chemistry, and biology contributing uniquely to human understanding of the natural world. In Nigeria, the National Policy on Education (NPE, 2014) underscores the importance of science as an activity-based, experiential subject that fosters problem-solving skills and innovation. However, despite this recognition, student achievement in Biology at the senior secondary level has remained persistently poor. Data from the West African Examinations Council (WAEC) spanning 2017 to 2024 reveal an average credit-level pass rate of only 44.90% in Adamawa State, with yearly fluctuations that indicate inconsistent and unsatisfactory performance (WAEC Report, 2017–2024). Scholars attribute this underachievement to several

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026363

factors, including ineffective instructional strategies, shortage of qualified teachers, inadequate instructional materials, and limited student motivation (Adesoji, 2008; Akintola, 2019). Traditional lecture methods that emphasize rote learning often fail to engage students meaningfully, prompting calls for learner-centered approaches that encourage active participation and conceptual understanding (Sakiyo & Kala, 2018; Oniya & Adefila, 2020). In response to these challenges, researchers have explored innovative instructional strategies such as analogy and guided inquiry. Analogy is an instructional approach that compares unfamiliar concepts with familiar ones to facilitate understanding, enabling students to transfer knowledge from known domains to new contexts (Abimbola, 2013; Richland & Simms, 2015). Studies by Akintola (2019) and Oniya (2020) demonstrated that analogy-enhanced instruction significantly improved students' achievement in Biology compared to conventional methods. Similarly, guided inquiry is a student-centered strategy that involves careful planning, ongoing assessment, and targeted intervention by teachers to guide students through the process of asking questions, investigating phenomena, and constructing their own understanding (Joda, Ugwuadu & James, 2024). This approach encourages learners to observe events, collect and interpret data, and take responsibility for their learning. Obadipe et al. (2020) found that guided inquiry significantly increased academic achievement in Biology relative to traditional lecture methods, while Mohammed and Joda (2017) reported that students taught with guided inquiry demonstrated higher achievement, although lecture methods were found to be more effective for content retention.

Beyond achievement, students' interest in Biology is a critical factor that influences sustained learning, curiosity, and career aspirations. Interest refers to the eagerness to explore living organisms, their functions, and their interactions with the environment, and it has been shown to enhance attention, memory retention, and active engagement (Freeman, 2017; Yan, 2021). However, research on gender differences in interest and achievement has produced inconclusive findings. While some studies reported that female students exhibited higher interest in science subjects (Onu, Anyaegbumam & Uzoigwe, 2020; Usang & Okoli, 2021), others found no significant gender differences (Okekeokosisi & Okigbo, 2021; Yunusa, Abdulwahid & Adullahi, 2014). Similarly, studies on instructional strategies revealed that analogy and guided inquiry are generally not gender-sensitive and promote achievement across both male and female students (Oniya, 2020; Obadipe et al., 2020). These persistent challenges and inconclusive findings underscore the need for further investigation into the effects of analogy and guided inquiry instructional strategies on students' academic achievement and interest in Biology, with particular attention to gender as a moderating variable.

Statement of the Problems

The persistent decline in students' academic achievement in senior secondary Biology represents a multifaceted problem rooted in the continued dominance of teacher-centered instructional methods that fail to foster deep conceptual understanding or engagement, a disconnect between an examination-focused curriculum and the development of practical, real-world skills, and a host of compounding factors including insufficient qualified teachers, inadequate laboratory infrastructure, and overcrowded classrooms. This crisis is empirically underscored by consistently poor performance in external examinations, such as WAEC's 2015 record showing only 38.47% of over a million candidates achieving a credit pass, and NECO Chief Examiners' Reports from 2018 to 2023 that repeatedly cite widespread underachievement in Biology alongside other sciences. Compounding these issues is the abstract nature of key Biology topics like genetics and ecology, which are difficult to convey through passive learning, alongside persistent gender-related disparities that continue to

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026363

affect achievement outcomes. Consequently, this study is designed to address these core problems by investigating whether innovative, constructivist-aligned strategies namely analogy and guided inquiry can significantly enhance students' academic achievement and interest in Biology, and crucially, whether these approaches can mitigate the existing achievement gap between male and female students.

Purpose of the Study

The main purpose of this study is to investigate the Effects of Analogy and Guided Inquiry Instructional Strategies on Students' Academic Achievement and Interest in Biology in Senior Secondary Schools in Adamawa State, Nigeria. Specifically, the study to determines:

1. The effect of analogy, guided inquiry instructional strategies and lecture method on students' academic achievement in Biology.
2. The effects of analogy, guided inquiry instructional strategies and lecture method on student interest in biology.
3. The effects of analogy, guided inquiry instructional strategies on students' academic achievement based on gender.

Research Questions

The following research questions were raised to guide the study:

1. What are the pretest and posttest mean achievement score of students taught biology using the analogy, guided inquiry instructional strategy and those taught using lecture method?
2. What are the pretest and posttest mean interest scores of students taught biology using analogy, guided inquiry instructional strategies and lecture method in Adamawa state?
3. What are the pretest and posttest mean achievement score of students taught biology using analogy and guided inquiry instructional strategies based on gender in Adamawa state?

Hypotheses

The following null hypotheses were formulated and were tested at 0.05 level of significance.

H_{O1}: There is no significant difference in the academic Achievement of students taught biology using the analogy, guided inquiry instructional strategy and those taught using lecture Strategy in Adamawa state.

H_{O2}: There is no significant difference in the student interest when taught Biology using Analogy, guided inquiry instructional strategy and lecture method in Adamawa state.

H_{O3}: There is no significant gender difference on senior secondary school students' academic Achievement in biology when taught analogy and guided inquiry instructional strategies.

Research Methodology

The study employed a quasi-experimental design, specifically a non-randomized pretest-posttest control group approach, to examine the effects of instructional strategies on students' achievement and interest in Biology, with quasi-experimental designs being appropriate when random assignment is impractical and permits the use of intact classes (Eliopoulos, 2004; Offor, 2000; Sambo, 2005). The study was conducted in Adamawa State, Northeastern Nigeria, a region with a diverse population, agricultural economy, and well-established educational infrastructure, and the population consisted of all 48,760 SSII students offering Biology in the 384 public senior secondary schools (Post Primary School Management Board, 2025). A sample of 436 SSII students from six selected schools in Yola and Gombi zones was chosen using a multistage sampling technique involving simple random sampling to identify zones, purposive sampling to select schools meeting inclusion criteria (co-educational status, functional Biology laboratories, qualified teachers), and

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026363

assignment of intact classes to experimental groups (Analogy and Guided Inquiry) and a control group (conventional lecture-based instruction). Two instruments were used for data collection: the Biology Achievement Test (BAT), a 50-item multiple-choice test adapted from WAEC past questions (2019–2024) aligned with the SSII Biology curriculum focusing on ecology, genetics, and the circulatory system, and the Biology Students' Interest Questionnaire (BSIQ), a standardized 5-point Likert scale questionnaire validated against Hidi and Renninger's (2006) Four-Phase Model of Interest Development, with reliability indices of 0.81 and 0.82 respectively. Students were pre-tested to establish baseline equivalence, after which the intervention lasted six weeks with four trained research assistants delivering lessons under supervision using structured lesson plans, followed by post-test and post-interest assessments. Collected data were scored, coded, and analyzed using SPSS version 25, with descriptive statistics (mean and standard deviation) answering research questions and inferential statistics (ANCOVA and MANCOVA) testing hypotheses at the 0.05 significance level.

Presentation Of Results

Answers to research Questions

Research Question 1: What are the pretest and posttest mean achievement score of students taught biology using the analogy, guided inquiry instructional strategy and those taught using lecture Strategy in Adamawa state?

Table 1: Mean and Standard Deviation of Pre – Test and Post Test Scores Difference of Students taught Biology using Analogy, Guided Inquiry and Lecture Instructional Strategies

Group		Pre – test		Post – test		Mean difference
	n	M	S. D	M	S. D	
Analogy	140	23.24	4.07	33.94	6.16	10.70
Guided inquiry	142	22.76	3.43	29.05	4.19	6.29
Lecture	154	21.83	5.01	24.17	3.24	2.34

Table 1 shows that students in the analogy group had the highest gain (pretest mean = 23.24, SD = 4.07; posttest mean = 33.94, SD = 6.16; mean difference = 10.70), followed by the guided inquiry group (pretest mean = 22.76, SD = 3.43; posttest mean = 29.05, SD = 4.19; mean difference = 6.29), and finally the lecture group (pretest mean = 21.83, SD = 5.01; posttest mean = 24.17, SD = 3.24; mean difference = 2.34). While all three instructional strategies led to significant improvements in students' Biology achievement, the analogy strategy produced the most substantial gain, followed by guided inquiry and then the lecture method.

Research Question 2: What are the pretest and posttest mean interest scores of students taught biology using analogy, guided inquiry instructional strategies and lecture method in Adamawa state**?**

Table 2. Descriptive Analysis of Students' Pretest and Posttest Mean Interest Scores of Experimental and Control Groups

Group		Pre – test		Post – test		Mean difference
	n	M	S. D	M	S. D	
Analogy	140	2.35	0.22	2.96	0.33	0.61
Guided inquiry	142	3.09	0.76	3.47	0.26	0.38
Lecture	154	2.17	0.35	2.38	0.51	0.21

Table 2 reveals that the analogy group recorded the highest gain in mean interest scores (pretest mean = 2.35, SD = 0.22; posttest mean = 2.96, SD = 0.33; mean difference = 0.61), followed by the guided inquiry group (pretest mean = 3.09, SD = 0.76; posttest mean = 3.47, SD = 0.26; mean

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026363

difference = 0.38) and the lecture group (pretest mean = 2.17, SD = 0.35; posttest mean = 2.38, SD = 0.51; mean difference = 0.21). Thus, while all three instructional strategies improved students' interest in Biology, the analogy strategy produced the most substantial increase, with guided inquiry also showing a notable improvement over the conventional lecture method.

Research Question 3: What are the pretest and posttest mean achievement score of students taught biology using analogy and guided inquiry instructional strategies based on gender in Adamawa state?

Table 3: Mean and Standard Deviation of Pre – Test and Post Test Scores Difference of Male and Female Students taught Biology using Analogy and Guided Inquiry Instructional Strategies

Group	Gender	n	Pre – test		Post – test		Mean difference
			M	S. D	M	S. D	
Analogy	Male	62	17.62	4.17	26.83	4.69	9.21
	Female	78	14.03	3.04	22.66	3.05	8.63
Guided inquiry	Male	67	13.07	3.28	19.78	5.30	6.71
	Female	75	15.27	3.63	22.71	6.79	7.44

Across all three instructional strategies, both male and female students demonstrated improved achievement in Biology, with the analogy group yielding the largest mean score gains for both genders (males: +9.21; females: +8.63). Notably, male students showed slightly higher gains than females in the analogy groups, while in the guided inquiry group, females outperformed males with a mean difference of 7.44 compared to 6.71.

Testing the Hypotheses

HO_1: There is no significant difference in the academic Achievement of students taught biology using the analogy, guided inquiry instructional strategy and those taught using lecture Strategy in Adamawa state.

Table 4: One-way Analysis of Covariance of Students' Academic Achievement when Taught Biology with Analogy, Guided Inquiry Instructional Strategy and Lecture Strategy

Source	**Type III Sum of Square**	**Df**	**Mean Square**	**F**	**Partial Eta Square**	**Sig.**
Corrected Model	130514.687[a]	3	60804.609	270.604	0.538	0.00
Intercept	114845.077	1	114845.077	420.275	0.451	0.00
PRETEST	410.764	1	410.764	2.301	0.004	0.102
Strategy	120575.367	2	64321.758	281.359	0.7056	0.00*
Error	86215.043	434	156.874			
Total	1208507.000	436				
Corrected total	226742.570	435				

a. R Squared = .628 (Adjusted R Squared = .636); * =The mean difference is significant at the 0.05 level.

Table 4 revealed that there is significant difference of analogy, guided inquiry instructional strategy and lecture Strategy on the mean academic Achievement scores of students, $F_{(3,\ 434)}$ =281.359, P<0.05. Since the computed P-value (0.000) is less than 0.05 the null hypothesis is rejected. This implies that there is significant difference of teaching Strategy on students' academic Achievement in biology. Thus, students performed significantly differently in the three groups. This implies that the teaching Strategy may not be equally effective. Also, there is strong relationship between pretest and post test scores as indicated by partial eta squared value of 70.5%. This shows that the teaching Strategy are effective in enhancing student academic achievement in biology.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026363

HO_2: There is no significant difference in the student interest when taught Biology using Analogy, guided inquiry instructional strategy and lecture method in Adamawa state.

Table 5: One-way Analysis of Covariance of Students' Interest when Taught Biology with Analogy, Guided Inquiry Instructional Strategies and Lecture Strategy

Source	Type III Sum of Square	Df	Mean Square	F	Partial Eta Square	Sig.
Corrected Model	7.483[a]	3	2.027	6.024	0.032	0.00
Intercept	135.760	1	135.760	425.209	0.350	0.00
Interest before	0.310	1	0.310	0.654	0.003	0.334
Strategy	6.356	2	3.084	11.781	0.332	0.00*
Error	151.021	434	0.336			
Total	7203.182	436				
Corrected total	175.603	435				

a. R Squared = .043 (Adjusted R Squared = .036); * =The mean difference is significant at the 0.05 level.

Table 5 revealed that there is significant effect of analogy, guided inquiry instructional strategy and lecture Strategy on students' interest to biology, F**(**3, 434**)**=11.781, P<0.05. Since the computed P-value (0.000) is less than 0.05, the null hypothesis is rejected. This implies that there is significant effect of teaching Strategy on students' interest to biology. Also, there is strong relationship between pretest and posttest interest scores as indicated by the partial eta squared value of 3.3%. This shows that the students' interest to biology is affected by teaching Strategy in enhancing student academic Achievement in biology.

HO_3: There is no significant gender difference on senior secondary school students' academic Achievement in biology when taught analogy and guided inquiry instructional strategies.

Table 6: Summary of Independent Sample *t* – Test of Students' Academic Achievement Based on Gender when Taught Biology with Analogy and Guided Inquiry Instructional Strategies

Achievement scores	Gender	N	Mean	S. D	DF	t – value	P – value	Remarks
for students taught using analogy	M	62	38.67	10.75	139	5.01	0.000	H_{03} rejected
	F	78	25.80	12.46				
for students taught using guided inquiry	M	67	28.53	11.01	141	-3.37	0.000	H_{03} rejected
	F	75	31.17	13.79				

From Table 6, presents the analysis of independent sample *t* – test of students' academic Achievement based on gender when taught biology with analogy and guided inquiry instructional strategies. For students taught using analogy strategy t= 5.01; df =(1, 139), P<0.05. Since the computed P-value (0.000) is less than 0.05 level of significance, the null hypothesis is rejected. This implies that there is significant gender difference on students' academic Achievement in biology when taught with analogy. Also, For students taught using guided inquiry, t=3.37, df = (1, 141), P<0.05. Since the computed P-value (0.000) is less than 0.05 level of significance, the null hypothesis is rejected. This implies that there is significant gender difference on students' academic Achievement in biology when taught with guided inquiry.

Summary of Major Findings

The major findings of the study are as follows:

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026363

1. There is significant effect of analogy, guided inquiry instructional strategy and lecture Strategy on the academic Achievement of students in Biology (p=0.000 <0.05).
2. There is significant effect of analogy, guided inquiry instructional strategy and lecture Strategy on students' interest to biology (p=0.000 <0.05).
3. There is significant gender effect on students' academic Achievement in biology when taught with analogy and guided inquiry instructional strategies (p=0.000 <0.05).

Discussion of Findings

There is significant effect of analogy, guided inquiry instructional strategy and lecture Strategy on the mean academic Achievement scores of students. This finding agree with Musa (2020) revealed that students taught using analogy-based instruction significantly outperformed those taught using the conventional Strategy. Indicating that analogy-based instruction enhanced students' comprehension and retention of biological concepts. In the same vein, Obinna (2022) results indicated that students in the guided inquiry group significantly outperformed those in the lecture-based group. Sharma (2019) showed that students taught through guided inquiry significantly outperformed those in the control group, with a mean posttest score significantly higher than their counterparts. Similarly, Ahmed (2021) who revealed that guided inquiry and analogy-based instruction significantly improved students' academic Achievement compared to the conventional lecture Strategy in biology. However, guided inquiry yielded a higher mean score than analogy-based instruction, indicating that it was more effective in fostering students' understanding of Biology concepts. On the contrary to the present study revealed that analogy is better than guided inquiry and lecture Strategy. This suggested that analogy-based instruction helped students relate abstract biological concepts to familiar real-life situations, which enhanced comprehension.

The findings revealed that there is significant effect of analogy, guided inquiry instructional strategy and lecture Strategy on students' interest to biology. This finding agreed with Martínez and López (2020) experimental group demonstrated a significant improvement in both interest and achievement compared to the control group. Martínez and López found that guided inquiry-based instruction positively influences students' academic Achievement and cultivates a heightened interest in Biology. Also, Mensah and Boateng (2020) found that guided inquiry-based learning enhanced students' interest in Biology. Similarly, Sari and Yusuf (2020) revealed that students taught through analogy-based strategies scored significantly higher than those taught via traditional Strategy. Additionally, the experimental group exhibited a greater interest in Biology. The study also revealed that there is significant gender difference on students' academic Achievement in biology when taught with analogy and guided inquiry instructional strategies. This finding agreed with Zhao and Liu (2021) reported that female students tend to outperform their male counterparts in Biology, particularly when the curriculum includes real-world applications such as healthcare and environmental science. This aligns with findings from Sukoco and Kurniawan (2020), who noted that female students typically show more engagement with topics like ecology and environmental conservation, which are perceived as more relatable, while male students demonstrate greater interest in technical aspects such as genetics and biotechnology. On the other hand, Bamberg and Miller (2020) demonstrated that male students tend to perform better in competitive classroom environments focused on factual recall, whereas female students show more persistence in tasks requiring conceptual understanding and critical thinking. On the contrary, Ferrer et al. (2021) found that while male and female students perform similarly in standardized Biology tests, female students excel in applied knowledge tasks, such as solving real-world biological problems, which require critical thinking and application of knowledge.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026363

Conclusion

The study shows that analogy and guided inquiry instructional strategies were significantly effective and improved students' academic Achievement when compared with lecture method when taught biology in senior secondary schools in Adamawa state. The study also showed that gender had an influence on students' Achievement, although it did not significantly affect their interest in Biology. Analogy and guided inquiry instructional strategies are effective tools for enhancing teaching and learning in Biology. When properly implemented, these Strategy make lessons more engaging, promote deeper understanding, and stimulate students' curiosity and motivation to learn.

Recommendation

Based on the findings of the study, the following were recommended:

1. Biology teachers should adopt analogy and guided inquiry instructional strategies in their teaching to enhance students' understanding and academic achievement.
2. Teachers should receive continuous training and professional development on the effective use of analogy and guided inquiry strategies to improve instructional delivery and classroom effectiveness.
3. Teachers and curriculum planners should ensure that teaching materials and strategies are gender-inclusive to promote equal learning opportunities and minimize Achievement disparities between male and female students.

References

Abimbola, I. (2013). The role of analogies in learning science. *International Journal of Science Education, 35*(4), 567–580.

Adedeji, T. (2018). Innovative teaching strategies and students' achievement in science. *Journal of Education Research, 12*(2), 45–56.

Adesoji, F. (2008). Students' performance in biology and teaching methods in Nigerian secondary schools. *African Journal of Educational Studies, 7*(1), 21–30.

Akintola, F. (2019). Effects of analogy strategy on senior secondary school students' achievement in biology. *Journal of Science Education, 22*(3), 123–134.

Anderson, L. (2022). Active learning strategies in biology education. *Education Research International, 18*(1), 78–90.

Calik, M., & Ayas, A. (2005). The effect of analogy-based instruction on conceptual understanding in biology. *Journal of Biological Education, 39*(2), 68–72.

Freeman, S. (2017). Interest and motivation in science learning. *Science Education Review, 21*(2), 33–45.

Haglund, J., Jeppsson, F., & Andersson, B. (2012). Using analogies to teach biological concepts. *Journal of Science Teaching, 44*(3), 210–225.

Joda, M., Ugwuadu, B., & James, T. (2024). Effects of guided inquiry on students' achievement in biology. *International Journal of Science Pedagogy, 29*(1), 89–102.

Kala, A. (2018). Student-centered instructional strategies in science education. *Nigerian Journal of Educational Research, 15*(1), 54–65.

Mesuit, R., & Hoft, J. (2015). Promoting critical thinking in science classrooms. *Journal of Research in Science Teaching, 52*(7), 901–918.

Mohammed, A., & Joda, M. (2017). Guided inquiry versus lecture strategy in secondary school biology. *African Journal of Science Education, 14*(2), 112–125.

Nawaf, R. (2016). Analogy in science teaching. *Science Education International, 27*(3), 215–223.

Nwafor, C. (2018). Students' interest and achievement in biology. *Journal of Science and Mathematics Education, 10*(1), 44–58.

Obadipe, T., Ogunleye, B., Edegbai, S., & Adeyemo, O. (2020). Guided inquiry and academic achievement in biology. *International Journal of Science Learning, 38*(4), 299–315.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026363

Olasheinde, F., in Akintola, F. (2019). Teaching strategies and student achievement in biology. *African Journal of Science Education, 17*(2), 33–42.

Oniya, M., & Adefila, A. (2020). Science education and national development. *Nigerian Journal of Science Education, 23*(1), 12–25.

Richland, L., & Simms, N. (2015). Analogy use in science classrooms. *Cognition and Instruction, 33*(2), 89–115.

Ruhi, M. (2003). Using analogies to enhance conceptual understanding. *Journal of Science Education, 27*(1), 41–50.

Sakiyo, T., & Kala, A. (2018). Science, technology, society, analogy and guided inquiry instructional strategies. *Journal of Science Teaching, 40*(3), 177–190.

Singer, S. (2015). Teaching abstract biological concepts. *International Journal of Biology Education, 9*(2), 55–66.

Usang, B., & Okoli, E. (2021). Gender differences in science interest. *African Educational Research Journal, 19*(2), 65–74.

WHO. (2011). Gender and education: Norms, roles, and relationships. *World Health Organization Journal, 12*(1), 1–15.

Yunusa, M., Abdulwahid, A., & Abdullahi, L. (2014). Gender and achievement in science. *Journal of Science Education Research, 10*(2), 33–45.

Yan, Q. (2021). Enhancing students' interest in biology through active learning. *Journal of Biological Education, 55*(1), 12–20.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026364

Effect Of Reproductive Health Education Intervention Programme on Risky Sexual Behaviours Among Undergraduate Female Students in North-West, Nigeria

YUSUF, Abdulkabir Toriola[1]
y.toriola@yahoo.com;
08163471528;
https://orcid.org/0000-0001-6474-8649

YAKUBU, Safiya[1]
safiyayakububbk@gmail.com
2347066928432

ISIAQ, Abdulmuhit Temitope[2]
aisiaq@education.abu.edu.ng;
2348102040184
https://orcid.org/0000-0002-4871-8738

ALI, Babangida[3]
babangidaali1@gmail.com
+2348168333991

[1]Department of Health Education, Federal University of Education, Zaria, Nigeria.
[2]Department of Human Kinetics and Health Education, Ahmadu Bello University, Zaria, Nigeria
[3]Department of Nursing, Kaduna State College of Nursing Sciences, Kafanchan, Nigeria

Abstract

Risky sexual behaviours among female undergraduate students in Nigerian universities pose significant threats to reproductive health outcomes, including sexually transmitted infections, unintended pregnancies, and academic disruption. Despite documented prevalence, experimental evidence evaluating interventions remains scarce in Nigeria's North-West Zone. This study examined the effect of a reproductive health education intervention programme on risky sexual behaviours among female undergraduate students in federal universities in the North-West Zone, Nigeria. A quasi-experimental pre-test/post-test design was employed. One hundred female undergraduates were recruited from Ahmadu Bello University, Zaria (experimental group, n=50) and Usmanu Danfodiyo University, Sokoto (control group, n=50) through multistage sampling. The experimental group received a six-week reproductive health education programme, while the control group received a placebo intervention. Data were collected using a validated researcher-developed questionnaire (reliability index = 0.92) and analysed using paired-samples and independent-samples t-tests at a 0.05 significance level. The intervention produced a statistically significant reduction in risky sexual behaviours within the experimental group, with mean scores declining from 2.67 at pre-test to 1.67 at post-test ($t(49) = 23.87$, $p < 0.001$). Post-intervention comparison revealed significantly lower risky sexual behaviour scores in the experimental group relative to the control group ($M = 1.67$ vs. 2.32; $t(98) = 25.74$, $p < 0.001$). Reproductive health education interventions significantly reduce risky sexual behaviours among female undergraduates. University administrations and policymakers should institutionalize such programmes within tertiary institutions to promote safer sexual practices.

Keywords: Reproductive health education, risky sexual behaviours, female undergraduate students, quasi-experimental study, North-West Nigeria

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026364

Introduction

Risky sexual behaviour, defined as a range of unsafe sexual practices including unprotected intercourse, multiple sexual partnerships, inconsistent contraceptive use, and engagement with sexually explicit content, has emerged as an increasingly prevalent phenomenon among undergraduate students in Nigerian universities (Magaji-Yusuf & Esere, 2022). Although sexual autonomy is a normal dimension of young adult development, risky sexual behaviours pose significant threats to female students, including heightened vulnerability to Sexually Transmitted Infections (STIs), unintended pregnancies, unsafe abortion, and compromised academic performance (Arogundade, 2022). These adverse outcomes align with the global agenda for Sustainable Development Goal (SDG) 3 (good health and well-being), which emphasises improving health outcomes through quality care and preventing avoidable deaths, and SDG 5 (gender equality), which underscores the need to protect women's sexual and reproductive health rights within educational settings. In Nigeria's North-West Zone, the burden of risky sexual behaviour is compounded by socio-cultural norms that discourage open discussion of sexuality, inadequate access to reproductive health services, and pervasive peer pressure and poverty that drive unsafe practices (Akorede et al., 2022). These challenges undermine the implementation of reproductive health education and contribute to low adherence to protective sexual behaviours, with studies documenting that among female undergraduates in Nigerian institutions, up to 28.3% had undergone induced abortion and nearly half had never used contraceptives (Nwankwo & Bankole, 2022). Across Nigerian universities more broadly, risky sexual behaviours manifest through unprotected vaginal, anal, and oral sex, engagement with multiple partners including older male figures, pornography use, and masturbation, often driven by financial pressures, inadequate supervision, peer influence, and exposure to explicit media content (Arogundade, 2022).

Despite the well-documented risks, sexual behaviours among female undergraduates in university settings remain inconsistent with recommended reproductive health practices, creating sustained risks for students' health and academic outcomes. In the North-West Zone, evidence indicates that female undergraduates may possess awareness of reproductive health risks yet demonstrate poor preventive behaviours, including low contraceptive use, inconsistent condom use, and inadequate strategies to reduce the consequences of unsafe sexual activity (Biu et al., 2025). This practice gap has been observed in recurring reports of STIs, unintended pregnancies, pelvic inflammatory diseases, and psychosocial stressors among sexually active female students, suggesting that available health messaging or general awareness campaigns alone may be insufficient to produce durable behavioural change in students' sexual routines (UNESCO, 2021). A feasible and scalable solution is strengthening female undergraduates' competencies through reproductive health education embedded within university health promotion systems, targeting not only knowledge acquisition but also sustained behavioural adoption and responsible sexual decision-making.

Reproductive health education comprises a set of structured instructional practices intended to equip individuals with knowledge and skills to make informed decisions regarding their sexual and reproductive health, foster healthy relationships, and encourage responsible behaviours (WHO, 2023). Because students' behaviours often reflect underlying knowledge, attitudes, and socio-cultural influences, targeted educational strategies are frequently employed to improve adherence to protective reproductive health behaviours, especially where peer pressure, financial constraints, and high social vulnerability contribute to risk-taking (Akorede et al., 2019; Biu et al., 2025). International and national guidance supports education as a core reproductive health intervention component, noting that effective programmes should be competency-based and culturally sensitive

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026364

to influence routine behaviour and reduce adverse reproductive health outcomes, particularly among young women aged 15–24 years who disproportionately bear the burden of new HIV infections globally (WHO, 2022). Evidence from sub-Saharan Africa and comparable university settings confirmed that educational interventions can improve students' reproductive health knowledge and may reduce engagement in high-risk sexual behaviours. For instance, reproductive health programmes in university settings have been associated with significant improvements in students' awareness of STIs, contraceptive options, and the psychosocial consequences of unprotected sexual activity (Harande et al., 2025; Nwankwo & Bankole, 2022). Similarly, educational interventions targeting sexual behaviour have been reported to yield meaningful improvements in knowledge and sexual negotiation skills, supporting training as a pragmatic approach to reducing risky practices in comparable settings (Harande et al., 2025). Collectively, these findings indicate that education can address behavioural gaps in reproductive health practice, providing a rationale for intervention-focused research in settings such as Nigeria's North-West Zone, where risky sexual behaviour and its associated consequences remain prominent (Magaji-Yusuf & Esere, 2022).

While descriptive studies in Nigeria and comparable settings have repeatedly documented suboptimal reproductive health behaviours and persistent risky sexual practices, many investigations primarily assess knowledge, attitudes, and self-reported practices without testing educational interventions capable of producing sustained behavioural change in students' daily lives (Arogundade, 2022). In the North-West Zone, findings that a substantial proportion of female undergraduates remain sexually active under high-risk conditions, alongside reports of serious reproductive health consequences, underscore the urgent need to move beyond problem description toward evaluated solutions (WHO, 2019). Moreover, repeated documentation of adverse outcomes such as STIs, unintended pregnancies, and academic disruption highlights a concerning gap between reproductive health awareness, resource availability, and consistent day-to-day protective behaviour, implying that one-off sensitisation efforts may not be sufficient to ensure safe and healthy sexual routines among high-exposure student populations (UNESCO, 2021). Accordingly, a key research gap is the scarcity of experimental or quasi-experimental studies in federal universities that measure the effectiveness of reproductive health education interventions on female undergraduates' risky sexual behaviours in Nigeria's North-West Zone. This study is novel in its intervention-focused approach by implementing and evaluating a reproductive health education programme within federal universities in the North-West Zone of Nigeria, to determine whether such training can measurably improve protective sexual health behaviours. Therefore, the study objective is to examine the effect of a reproductive health education intervention programme on risky sexual behaviours among female undergraduate students in federal universities in the North-West Zone, Nigeria.

Research Methodology

This study employed a quasi-experimental research design incorporating pre-test and post-test assessments for both the experimental group (EG) and control group (CG). The experimental group participated in a reproductive health education intervention programme, whereas the control group received no intervention. The study was conducted in federal universities in the North-West Zone, Nigeria. The target population comprised female undergraduate students enrolled in Ahmadu Bello University (ABU), Zaria, and Usmanu Danfodiyo University, Sokoto (UDUS), with a combined accessible population of 82,163 students based on the 2019/2020 and 2022/2023 academic session admission records. A total sample of 100 participants was recruited: 50 female undergraduate students from ABU (experimental group) and 50 from UDUS (control group). This sample size is consistent with quasi-experimental research standards and is considered sufficient to detect

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026364

meaningful intervention effects and enhance the generalisability of findings. A multistage sampling procedure was adopted. This included purposive sampling to identify faculties without health-related curricula across both institutions. Homogeneous purposive sampling was then employed to select participants with similar characteristics from the Departments of relevant faculties. Participants were allocated such that ABU served as the experimental site and UDUS as the control site. The selection process minimised selection bias and strengthened internal validity.

Eligible participants were female undergraduate students currently enrolled in the departments of the selected federal universities, provided informed consent, and were available to complete all stages of assessment: pre-test and post-test. Participants were also required to have exhibited risky sexual behaviours as identified during the screening process and to be accessible for the entire duration of the study period. Data were collected using a researcher-developed questionnaire. Responses were measured using a modified four-point Likert rating scale: Strongly Agree (SA) = 4 points, Agree (A) = 3 points, Disagree (D) = 2 points, and Strongly Disagree (SD) = 1 point. A mean aggregate score of ≥ 2.50 was adopted as the benchmark for risky sexual behaviour, while scores below 2.50 indicated positive sexual behaviour. Face, content, and construct validity were established through expert review by specialists in Health Education, Sociology, and Nursing Science. Their feedback was incorporated to refine the final instrument before data collection. A pilot study was conducted at Bayero University, Kano, using 20 female undergraduate students who shared similar characteristics with the target population but were not part of it. The split-half method was employed to assess reliability, and data were analysed using Spearman-Brown's Prophecy Formula, yielding a reliability index of 0.92, indicating excellent reliability. This interpretation is consistent with reliability guidance that values above 0.75 are regarded as excellent.

A reproductive health education intervention manual and lesson plan were developed by the researcher to guide the instructional process. The manual covered: patterns of sexual behaviours among female undergraduates, including masturbation, vaginal, anal, and oral sex; risks and consequences of risky sexual behaviours; STI prevention strategies and correct use of protective measures; decision-making skills for healthy intimate relationships; and core reproductive health behaviours, including STI screening, contraception awareness, and boundary-setting in relationships. Four research assistants were trained to support data collection and intervention delivery. Data collection occurred across three stages: pre-intervention (pre-test), intervention, and post-intervention (post-test). An introductory letter was obtained to facilitate participant consent during data collection. After institutional permissions, pre-test data were obtained from both groups using the questionnaire. During the screening stage, participants were recruited and pre-tested. In the intervention stage, the experimental group received the reproductive health education programme, delivered over six weeks with weekly sessions using lectures, demonstrations, discussions, and practical activities, with instructional materials including projectors, manuals, and lesson plans. The control group received no intervention during the same period. Post-test data were collected immediately after the six-week programme. Pre-test and post-test data were collated for within-group and between-group comparisons. Participation was voluntary, and written informed consent was obtained before enrolment through an introductory letter. Participants were informed about the study objectives, procedures, anticipated benefits and risks, confidentiality protections, and their right to withdraw at any time without penalty. To ensure confidentiality, the copies of the questionnaire were coded without personal identifiers. Data were stored securely and accessible only to the research team.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026364

Data were analysed using Statistical Package for Social Sciences (SPSS) version 31. Descriptive statistics (frequencies and percentages) summarised participants' demographic characteristics, while means and standard deviations addressed the study's research questions. Inferential analyses were conducted at a 0.05 level of significance. A paired-samples t-test assessed within-group changes in sexual behaviours across assessment time points among participants in the experimental group. An independent-samples t-test compared post-test scores between the experimental and control groups to determine the intervention effect between the two independent groups.

Presentation Results

Table 1: Socio-Demographic Characteristics of the Respondents (n = 100)

Variables	Variable options	Experimental		Control	
		Freq Pre-test	Percentage (%)	Freq Post-test	Percentage (%)
Age	18-22 Years	25	50.0	27	54.0
	23-27 Years	20	40.0	21	42.0
	28 years and above	5	10.0	2	4.0
	Total	**50**	**100**	**50**	**100**
Mean Age	**23.48 ±1.6**			**22.88 ±2.4**	
Level of Study	100 level	5	10.0	3	6.0
	200 level	12	24.0	11	22.0
	300 level	20	40.0	27	54.0
	400 level	13	26.0	9	18.0
	Total	50	100	50	100
Marital Status	Single never married	18	36.0	43	86.0
	Cohabiting	29	58.0	5	10.0
	Married	0	0.00	2	4.0
	Separated/Divorced	3	6.0	0	0
	Total	**50**	**100**	**50**	**100**
Ethnic group	Hausa	16	32.0	27	54.0
	Yoruba	09	18.0	17	34.0
	Igbo	3	6.0	6	12.0
	Nupe	3	6.0	Nil	Nil
	Idoma	3	6.0	Nil	Nil
	Igbira	5	10.0	Nil	Nil
	Kataf/southern Kaduna	11	22.0	Nil	Nil
	Total	**50**	**100**	**50**	**100**
Current place of accommodation	Outside campus (with parents /guardian/relatives)	10	20.0	16	32.0
	Outside campus (rented apartment)	24	48.0	11	22.0
	Hostel on the campus	2	4.0	9	18.0
	Outside campus with a boy/girl friend	14	28.0	14	28.0
	Total	**50**	**100**	**50**	**100**
Students' current monthly income	₦10, 000-N20,000	21	42.0	19	38.0
	₦21,0000-₦30,000	11	22.0	18	36.0
	₦31,000-₦40,000	10	20.0	8	16.0
	₦41, 000 and Above	8	16.0	5	10.0
	Total	**50**	**100**	**50**	**100**

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026364

Parents' average monthly income	₦1, 000-₦10,000	22	44.0	21	42.0
	₦11,0000-₦ 20,000	19	38.0	13	26.0
	₦21,000-₦30,000	5	10.0	4	8.0
	₦31,000-₦40,000	4	8.0	12	24.0
	Total	**50**	**100**	**50**	**100**
Parent Occupation	Public/civil servant	29	58.0	16	32.0
	Business/ trading	13	26.0	11	22.0
	Farming	8	16.0	23	46.0
	Total	**50**	**100**	**50**	**100**

The socio-demographic characteristics of the respondents show some notable similarities and differences between the experimental and control groups. In terms of age distribution, the majority of respondents in both groups were within 18–22 years (50.0% experimental; 54.0% control), followed by those aged 23–27 years (40.0% experimental; 42.0% control), while only a small proportion were 28 years and above, indicating that the sample largely comprised young undergraduates; this is further supported by the mean ages of 23.48 ± 1.6 years for the experimental group and 22.88 ± 2.4 years for the control group. Regarding the level of study, most respondents were in the 300 level (40.0% experimental; 54.0% control). A striking difference is observed in marital status, where a high proportion of the experimental group were cohabiting (58.0%) compared to only 10.0% in the control group, while most control respondents were single (86.0%).

Ethnically, the experimental group was more diverse, with representation from Hausa (32.0%), Yoruba (18.0%), and other minority groups, whereas the control group was dominated by Hausa (54.0%) and Yoruba (34.0%). In terms of accommodation, most experimental respondents lived in rented apartments off-campus (48.0%), whereas a higher proportion of control respondents resided with parents/guardians (32.0%) or in hostels (18.0%), although both groups had equal proportions (28.0%) living with a boyfriend or girlfriend. Income distribution shows that most students in both groups earned between ₦10,000 and ₦20,000 monthly, though the control group had slightly more respondents in the ₦21,000–₦30,000 range. Similarly, parents' income was largely concentrated within ₦1,000–₦20,000 for both groups, though more control respondents reported higher parental income (₦31,000–₦40,000). Also, parental occupation differed, with the majority of experimental respondents' parents being public/civil servants (58.0%), while farming was more common among parents of control respondents (46.0%).

Table 2: Mean Scores of Responses on the Effect of Reproductive Health Education Intervention Programme on the Risky Sexual Behaviours of Female Undergraduate Students in Federal Universities in North West Zone, Nigeria.

S/N	Items	Pre-test		Post-test		Mean Difference
		Mean	Std. Dev.	Mean	Std. Dev.	
1	I engage in sexual intercourse without using protection (e.g., condoms).	2.81	1.01	1.49	0.46	1.32
2	I have had multiple sexual partners within a short period of time.	2.79	1.23	1.58	0.44	1.21
3	I sometimes have sexual intercourse under the influence of alcohol or drugs.	2.65	0.65	1.62	0.53	1.03
4	I find it difficult to insist on condom use during sexual activity.	2.65	1.22	1.59	0.52	1.06

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026364

5	I engage in casual sex with partners I am not in a committed relationship with.	2.71	0.73	1.81	0.66	0.90
6	I have had unplanned sexual encounters.	2.56	0.75	1.87	0.73	0.69
7	I engage in transactional sex (sex in exchange for money, gifts, or favours).	2.63	1.02	1.67	0.72	0.96
8	I do not consistently use contraceptives during sexual activity.	2.58	0.86	1.75	0.46	0.83
	Aggregate Mean	**2.67**	**0.86**	**1.67**	**0.64**	**1.00**

(Decision Mean = 2.50)

The results presented in Table 2 indicated a substantial reduction in risky sexual behaviours among female undergraduate students after a reproductive health education intervention programme. At the pre-test stage, all item mean scores were above the decision mean of 2.50, with an aggregate mean of 2.67, affirming that risky sexual behaviours such as unprotected sex, multiple sexual partnerships, substance-influenced intercourse, and inconsistent contraceptive use were relatively prevalent among the respondents before the intervention. However, at the post-test stage, all item mean scores dropped below the decision mean, with an aggregate mean of 1.67, demonstrating a marked improvement in behavioural outcomes. The mean differences across all items, ranging from 0.69 to 1.32, reflect notable declines in engagement in these behaviours, with the highest reduction observed in unprotected sexual intercourse (mean difference = 1.32) and multiple sexual partnerships (mean difference = 1.21). These findings confirmed that the intervention programme was effective in increasing awareness, promoting safer sexual practices, and reducing exposure to sexual health risks among the participants.

Table 3: Mean Scores of Response on the Differences Between Experimental and Control Groups on the Risky Sexual Behaviours of Female Undergraduate Students in Federal Universities in North West Zone, Nigeria after Reproductive Health Education Intervention Programme.

S/N	Items	Control		Experimental		Mean Difference
		Mean	Std. Dev.	Mean	Std. Dev.	
1	I engage in sexual intercourse without using protection (e.g., condoms).	2.24	0.23	1.49	0.46	0.75
2	I have had multiple sexual partners within a short period of time.	2.25	1.41	1.58	0.44	0.67
3	I sometimes have sexual intercourse under the influence of alcohol or drugs.	2.24	0.16	1.62	0.53	0.62
4	I find it difficult to insist on condom use during sexual activity.	2.29	0.97	1.59	0.52	0.70
5	I engage in casual sex with partners I am not in a committed relationship with.	2.96	1.06	1.81	0.66	1.15
6	I have had unplanned sexual encounters.	2.29	0.19	1.87	0.73	0.42
7	I engage in transactional sex (sex in exchange for money, gifts, or favours).	2.14	1.03	1.67	0.72	0.47
8	I do not consistently use contraceptives during sexual activity.	2.16	1.05	1.75	0.46	0.41
	Aggregate	**2.32**	**0.76**	**1.67**	**0.64**	**0.65**

(Decision Mean = 2.50)

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026364

Table 3 shows the mean scores comparing the control and experimental groups on risky sexual behaviours among female undergraduate students after exposure to the reproductive health education intervention programme. The aggregate mean score for the control group (2.32) is notably higher than that of the experimental group (1.67), with a mean difference of 0.65, indicating that students who did not receive the intervention engaged more in risky sexual behaviours than those who participated in the programme. Although both group means fall below the decision mean of 2.50, suggesting a general tendency toward disagreement with risky behaviours, the consistently lower mean scores across all items in the experimental group demonstrate a stronger reduction in such behaviours. Specifically, the largest mean difference is observed in engagement in casual sex (mean difference = 1.15), followed by unprotected sexual intercourse (0.75) and difficulty insisting on condom use (0.70), indicating that the intervention had a substantial impact on improving safer sexual practices and assertiveness. Other areas, such as having multiple sexual partners (0.67), engaging in sex under the influence of substances (0.62), and transactional sex (0.47), also show meaningful reductions. Even the smallest differences, seen in unplanned sexual encounters (0.42) and inconsistent contraceptive use (0.41), still reflect positive behavioural change. The findings affirmed that the reproductive health education intervention programme was effective in reducing risky sexual behaviours among the experimental group compared to the control group.

Table 4: Paired Sample t-test representation of Pretest and Post-test on Reproductive Health Intervention Programme on the Risky Sexual Behaviours of Female Undergraduate Students after the Intervention in Federal Universities in North West Zone, Nigeria.

Risky Sexual Behaviour	N	Mean	Std. Dev.	Mean Difference	df	t-value	p-value
Pretest	50	2.67	0.86				
				1.00	49	23.87	< 0.001
Post-test	50	1.67	0.64				

t (df) = 23.87, p-value < 0.05

The results presented in Table 4 indicate a statistically significant effect of the reproductive health intervention programme on reducing risky sexual behaviours among female undergraduate students in Federal Universities in the North-West Zone, Nigeria. The mean score for risky sexual behaviour decreased markedly from 2.67 at pretest to 1.67 at post-test, yielding a mean difference of 1.00, which reflects a substantial reduction in engagement in such behaviours after the intervention. The paired sample t-test result ($t(49) = 23.87$, $p < 0.001$) shows that this difference is highly statistically significant, as the p-value is far below the 0.05 threshold. This implies that the observed change in behaviour is unlikely to have occurred by chance and can be attributed to the effect of the intervention programme. Therefore, the reproductive health education intervention was effective in significantly reducing risky sexual behaviours among the participants.

Table 5: Independent t-test Statistics on the Difference in Experimental and Control Groups on Risky Sexual Behaviours among Female Undergraduate Students in Federal Universities of North West Zone, Nigeria, After Reproductive Health Education Intervention Programme

Risky Sexual Behaviour	N	Mean	Std. Dev.	Mean Difference	df	t-value	p-value
Control	50	2.32	0.76				
				0.65	98	25.74	< 0.001
Experimental	50	1.67	0.64				

t (df) = 25.74, p-value < 0.05

Table 5 presents the independent t-test analysis comparing the mean scores of risky sexual behaviours between the experimental and control groups after the reproductive health education

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026364

intervention programme. The results show that the control group (N = 50) had a higher mean score (M = 2.32) compared to the experimental group (N = 50), which recorded a lower mean score (M = 1.67). The mean difference of 0.65 indicates a substantial reduction in risky sexual behaviours among participants exposed to the intervention. The calculated t-value of 25.74 with 98 degrees of freedom is statistically significant at $p < 0.001$, which is far below the 0.05 threshold for significance. This implies that the observed difference in mean scores between the two groups is not due to chance but is attributable to the effect of the reproductive health education intervention. Therefore, the intervention programme was highly effective in reducing risky sexual behaviours among female undergraduate students in the experimental group compared to those in the control group who did not receive the intervention.

Discussion of Findings

The findings of this study revealed a statistically significant reduction in risky sexual behaviours among female undergraduate students after the reproductive health education intervention programme ($t(49) = 23.87$, $p < 0.001$). The results corroborate the findings of Olaleye (2021) and Olaleye and Ajuwon (2024), whose quasi-experimental studies similarly demonstrated that educational interventions significantly reduced exposure to pornography and risky sexual behaviours among polytechnic students in Oyo and Lagos States. In the same vein, the present finding validates the conclusions of Mansor et al. (2023), whose cluster randomised controlled trial confirmed that a web-based intervention guided by the Prototype Willingness Model significantly reduced the intention and willingness to sext while improving sexual health knowledge and attitudes among diploma students. Furthermore, the present study conforms with the evidence provided by Bailey et al. (2015), whose systematic review of 19 randomised controlled trials established that interactive digital interventions produced moderate to positive effects on sexual health knowledge, self-efficacy, and sexual behaviour among young people aged 13–24 years, thereby supporting the current study's premise that educational interventions can yield meaningful behavioural change among undergraduate students.

The finding that the experimental group recorded a significantly lower mean score in risky sexual behaviours (M = 1.67) compared to the control group (M = 2.32) after the intervention ($t(98) = 25.74$, $p < 0.001$) also finds consensus with studies that documented associations between social media exposure, pornography consumption, and risky sexual practices among undergraduates, thereby reinforcing the imperative for targeted interventions. Specifically, the current finding aligns with Nnebue et al. (2020), Onasoga et al. (2020), and Dudafa and Titus (2025), all of whom established significant associations between social media use, exposure to sexually explicit content, and risky sexual behaviours among university students across Nigeria, lending justification to the intervention-focused approach adopted in the present study. Similarly, the result supports the positions of Adegbore et al. (2024) and Adegboyega (2019), who recommended health education interventions as remedies to pornography consumption and risky sexual practices among undergraduates, and whose observational findings provide a contextual basis that the current study transforms into measurable behavioural outcomes. Moreover, the present finding conforms with Guo et al. (2023), who reported that exposure to a school-based sexuality curriculum significantly improved sexual and reproductive health knowledge and mitigated risky sexual attitudes and behaviours among university freshmen in China, thus supporting the cross-cultural applicability of educational interventions in reducing sexual health risks. Conversely, the findings of this study stand in disagreement with the conclusions drawn from several cross-sectional and purely descriptive studies that, while identifying the prevalence and correlates of risky sexual behaviour, did not demonstrate the capacity for behavioural

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026364

modification through interventions. The present study contradicts the passive stance of Adinma et al. (2016), Chinedu and Enebe (2023), and Sinha et al. (2022), all of whom described risky sexual behaviours and their socio-demographic correlates without implementing or evaluating any intervention, thereby offering no evidence of the changeability of such behaviours. Similarly, the current finding disputes the sufficiency of the observational approach employed by Owan et al. (2020) and Alade and Aladenika (2023), who merely recommended the introduction of social media education without empirically testing its effect, as the current study demonstrates that mere recommendation without implementation yields no measurable change. Furthermore, the study refutes the implied passivity of Afrashteh et al. (2020) and Kolawole (2020), whose cross-sectional and descriptive designs documented risk factors and consequences of risky sexual behaviour without providing empirical evidence of intervention efficacy, a gap that the present quasi-experimental study effectively addresses by demonstrating statistically significant behavioural modification attributable to the intervention.

The researchers affirmed that reproductive health education intervention is an effective tool for reducing risky sexual behaviours among undergraduate students. The statistically significant pre-test to post-test reduction and the clear differential between experimental and control groups provide empirical support for this position. While cross-sectional studies have been valuable in establishing prevalence and associations, they fall short of demonstrating causality or behavioural change; it is the quasi-experimental design, as employed in this study, that provides the strongest evidence of the intervention's causal efficacy in modifying risky sexual practices.

Conclusion

This study conclusively establishes that a reproductive health education intervention programme significantly reduces risky sexual behaviours among female undergraduate students in Federal Universities in the North-West Zone of Nigeria, as evidenced by a highly significant pre-test to post-test mean reduction (2.67 to 1.67; $t(49) = 23.87$, $p < 0.001$) and a marked difference between experimental and control groups ($t(98) = 25.74$, $p < 0.001$), affirming that interventions are potent mechanisms for promoting safer sexual practices and reducing associated health risks among this population.

Recommendations

It is therefore recommended that

1. University administrations, health educators, and relevant government agencies institutionalise reproductive health education programmes within tertiary institutions to sustain behavioural change;
2. Curriculum planners should integrate sexual and reproductive health education into undergraduate academic programmes;
3. Further studies should explore the long-term retention of behavioural change and the scalability of such interventions across diverse student populations and geopolitical zones in Nigeria.

References

Adegbore, A. K., Adegbore, A. M., Akinniyi, R. J., Adegoke, J. I., Lawal, M. A., Olabode, A. T., & Yusuf, I. B. (2024). Predictors of risky sexual practice among undergraduates using social media in Osun State University, Osogbo. *Fountain Journal of Natural and Applied Sciences, 13*(1), 37–46. https://doi.org/10.53704/fujnas.v13i1.477

Adegboyega, L. O. (2019). Influence of social media on sexual behaviour of youth in Kwara State, Nigeria: Implications for counselling practice. *Canadian Journal of Family and Youth, 11*(1), 85–103. http://ejournals.library.ualberta.ca/index.php/cjfy

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026364

Adinma, J. I. B., Umeononihu, O., Adinma, D. E., & Eke, N. (2016). Sexual behaviour among students in a tertiary educational institution in Southeast Nigeria. *Advances in Reproductive Sciences, 4*, 87–92. https://doi.org/10.4236/arsci.2016.43010

Afrashteh, S., Abbasi-Ghahramanloo, A., Vali, M., Ghaem, H., Mohammadbeigi, A., Tabatabaee, H., & Kargarian-Marvasti, S. (2020). Risky sexual behavior among Iranian university students and its relationship with religiosity and familial support. *Family Medicine & Primary Care Review, 22*(4), 319–324. https://doi.org/10.5114/fmpcr.2020.100428

Akorede, S. N., Abdulfatah, H. A., Aliyu, M., & Alapa, J. O. (2019). Effects of reproductive health education intervention on sexual choices of female undergraduates of University of Ilorin. *Journal of Physical Education Research, 6*(2), 50–55.

Akorede, S. N., Akorede, A. A., Isiaq, A. T., & Yusuf, I. S. (2022). Influence of demographic characteristics on family planning adoption among females in Samaru, Kaduna State. *Kampala International University Interdisciplinary Journal of Social Science and Humanities, 3*(1), 1–12. http://dx.doi.org/10.59568/KIJHUS-2022-3-1-01

Alade, M., & Aladenika, O. E. (2023). Influence of social media use on sexual behaviour of undergraduates of Federal University of Technology (FUTA), Akure. *Sapientia Foundation Journal of Education, Sciences and Gender Studies, 5*(3), 195–204.

Arogundade, A. O. (2022). Factors influencing the sexual behaviour of undergraduate students in Adeleke University, Osun State, Nigeria. *International Journal of Health Sciences Research, 12*(10), 9–18. https://doi.org/10.52403/ijhsr.20221002

Bailey, J., Mann, S., Wayal, S., Hunter, R., Free, C., Abraham, C., & Murray, E. (2015). *Sexual health promotion for young people delivered via digital media: A scoping review. Public Health Research, 3*(13), 1-154. https://doi.org/10.3310/phr03130

Biu, A. A., Akorede, A. A., & Isiaq, A. T. (2025). Effect of health education intervention programs on emergency contraceptives awareness among university undergraduate female students in Jigawa State, Nigeria. *Zamfara International Journal of Education, 5*(3), 258–265. https://doi.org/10.64348/zije.202565

Chinedu, A. I., & Enebe, O. N. (2023). Risky sexual behaviour among students of a Nigerian tertiary institution. *African Health Sciences, 23*(4), 425–431. https://doi.org/10.4314/ahs.v23i4.46

Dudafa, U. J., & Titus, T. C. (2025). Social media video content consumption and risky sexual behaviour among undergraduate students in Bayelsa State, Nigeria. *Research Journal of Mass Communication and Information Technology, 11*(1), 40–53. https://doi.org/10.56201/rjmcit.vol.11.no1.2025.pg40.53

Guo, Y., Diao, J., Liu, T., Luo, L., Zhang, X., Li, Q., Cui, D., Li, R., Zheng, X., & Wang, P. (2023). Effects of a school-based sexuality curriculum on sexual and reproductive health in freshmen at Shandong University in China. *Advances in Physiology Education, 47*(3), 530–537. https://doi.org/10.1152/advan.00165.2022

Harande, S., Akorede, S. N., Yusuf, A. T., Ali, B., & Salisu, B. T. (2025). Effects of reproductive health intervention programme on multiple sexual partners behaviours among female undergraduate students in universities in North West-Zone, Zaria. *Journal of Research in Art and Social Science Education, 12*(1), 305–315.

Kolawole, A. A. (2020). Assessing the sexual health behaviour of teenage secondary school students in AMAC Local Government Area of FCT, Nigeria. *European Journal of Physical Education and Sport Science, 6*(2), 84–95. https://doi.org/10.5281/zenodo.3700157

Magaji-Yusuf, K., & Esere, M. O. (2022). Exposure to pornography as a correlate to sexual behaviour among University of Ilorin undergraduates: Implication to mental health. *Journal of Professional Counselling, 5*(2), 246–254.

Mansor, N., Ahmad, N., Md Said, S., Tan, K. A., & Sutan, R. (2023). Effectiveness of a theory-based digital animated video intervention to reduce intention and willingness to sext among diploma students: Cluster randomized controlled trial. *Journal of Medical Internet Research, 25*, e48968. https://doi.org/10.2196/48968

Nnebue, C. C., Duru, C. B., Uzoh, K. C., Udocor, B. E., Salaudeen, S. T., & Okonkwo, P. C. (2020). Social media and risky sexual practices among undergraduate students in a private

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026364

university in Southern Nigeria. *Asian Journal of Advanced Research and Reports, 13*(3), 11–21. https://doi.org/10.9734/ajarr/2020/v13i33059019

Nwankwo, C., & Bankole, A. (2022). Contraceptive use and abortion experiences among female undergraduates in Abuja, Nigeria. *BMC Women's Health, 22*, 115.

Olaleye, O. S. (2021). *Effects of social-media-delivered intervention on exposure to pornography and risky sexual behaviours among students of selected tertiary institutions in Oyo and Lagos States* (Doctoral thesis). University of Ibadan.

Olaleye, O. S., & Ajuwon, A. J. (2024). Effects of social-media delivered intervention on knowledge and exposure to pornography and sexual experiences among students of selected tertiary institutions in Southwest Nigeria. *Discoveries in Public Health, 3*(2), 43–53.

Onasoga, O. A., Aluko, J. O., Adegbuyi, S. N., Filade, O. A., & Shittu, H. I. B. (2020). Influence of social media use on sexual behaviour of undergraduate students in Ilorin, Kwara State, Nigeria. *Interdisciplinary Journal of Education, 3*(2), 112–122.

Owan, V. J., Ekpe, M. B., & Eneje, S. (2020). Undergraduates' utilization of social networking media and sexual behaviours in higher education: A case study. *Pedagogical Research, 5*(2), em0062. https://doi.org/10.29333/pr/7940

Sinha, S., Shree, S., Kumar, S., Singh, T., Kumar, S., Singh, V., & Chaudhary, S. (2022). Sexual attitude and behavior among medical students: A single institution survey. *Journal of Family Medicine and Primary Care, 11*(7), 3553–3558. https://doi.org/10.4103/jfmpc.jfmpc_352_22

UNESCO. (2021). *International technical guidance on sexuality education: An evidence-informed approach*. UNESCO Publishing.

World Health Organization. (2019). *Adolescent sexual and reproductive health*. World Health Organization.

World Health Organization. (2022). *Global health sector strategy on HIV 2022–2030*. World Health Organization.

World Health Organization. (2023). *Sexual health and its linkages to reproductive health: An operational approach*. World Health Organization.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026365

Qualitative Study on Level of Poverty in Africa in the 21st Century: Causes, Challenges and Way Forwards

MOHAMMED, Aishetu[1]
mammamndakotani@gmail.com
08065815536

BAWA, Sa'adatu Mohammed[2]
saadatudk22@gmail.com
08037440311
[1]Department of Biology, Umaru Sanda Ahmadu College of Education, Minna
[2]School of Secondary Education, Sciences Umaru Sanda Ahmadu College of Education, Minna
Niger State

Abstract

The paper examines poverty in Africa in 21st century and in Nigeria in particular. The paper highlights the causes of poverty such as poor governance, insecurity, diseases and climate change. It looks at the challenges of poverty such as inflation hunger, malnutrition, crime and other social vices. The paper offers various ways of minimizing poverty in Africa to include, agricultural revolution and biotechnology. The paper also highlighted the impact of Africa Russia summits to developing nations it heighted some of the advantages and disadvantages of hydroscopic farming. At the 78th United Nations General Assembly World leader's calls in more attention in areas like education, Job-creation hunger climate change and poverty reduction.

Keywords: Poverty, Biotechnology, Hydroscopic farming, Agricultural, Mechanization climate change

Introduction

Poverty, vulnerability remains a pressing challenge to Nigeria (FGN, 2023). Since COVID-19 the issue of hunger, malnutrition and poverty has being a major challenge to the world. The Millennium Development Goals (MDGs) (2015) stated that poverty is essentially about human deprivation. It is about lack of limited access to essential capacities that could facilitate long and healthy life. Poverty includes material deprivation (i.e food, shelter and the demand of access to basic services (i.e health, education). It includes other non-material conditions such as lack of insecurity, right to decision making, powerlessness, Ezema (2025) is of the opinion that poverty is a condition in which the state of living is with less that the smallest income to provide the minimum necessities of life under the influence of age, education, religion and ignorance. It is characterized by unemployment, hunger, sickness, crime and other social vices. Ezema's work on poverty includes a study on financial inclusion and poverty reduction in Nigeria which found that financial inclusion has a positive impact on reducing poverty (Ezema, 2025). Specifically, Eze and Alugbuo's (2021) study used the World Banks 2017 Global index survey to assess financial inclusions impact on poverty in Nigeria, indicating that financial inclusion reduced Nigerian household poverty. The Central Bank of Nigeria has set ambitious targets to increase financial inclusion, aiming to reach 95% of the population by 2024.

Poverty is hunger, lack of shelter, being sick and not being able to see a doctor, poverty is lack of unclean water, lack of representation and freedom (World Bank, 2026). According to the World Bank and the World Development Report condition is considered as being extremely poor by living on less than US$1 per day and moderately poor by living on less US$2 Daily (World Bank, 2026) it also project that about 1.1 billion people in 2001 had resources below US$1 a day and 2.7 billion lived

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026365

on less than US$2 a day. Poverty is not just confined to the African countries but it is a global phenomenon (World Bank, 2026). Poverty is also to be deprived of those goods services and pleasures which others around us take for granted (MDG's, 2015). The application of socio economic indication i.e per capital income, life expectancy at birth, access to health care services, access to portable drinking water, access to education, access to sanitary facilities indicates the extent of poverty in sub-Saharan Africa. The MDGs aimed to halve extreme poverty by 2015. The successor SDGs aim to end poverty in all its forms by 2030. In Nigeria initiatives like the ward based development programme is created to support small businesses. Poverty in developing countries "in the world of the poor people don't enjoy food, security, don't own many assets, are stunted and wasted, don't live long, can't read or write, don't have access to easy credit; are unable to save much, aren't empowered, can't ensure themselves well against crop failure or household calamity, don't have control over their own lives, don't trade with the rest of the world, live in unhealthy surroundings, suffer from in capabilities, are poorly governed. And more rarely suffer from a deteriorating natural disaster and have a high birth rate (Dasgupta, 2021).

Poverty Level in Africa

About 30 million more Africans fell into extreme poverty with (less than $1.9 per day) when COVID-19 pandemic struck in 2020. Before then 445 million people (about 34%) Africa's population lived below the poverty rates globally, with 23 of the world's poorest 28 countries at extreme poverty rates above 30%. Nigeria, Lesotho, Madagascar and Zambia had poverty levels comparable to China, Vietnam and Indonesia in the 1990s while the last three (3) countries have reduced extreme poverty drastically, African countries have not. Within Africa most poverty is concentrated in the sub-Saharan Africa region. Central Africa with the highest extreme poverty rate of 54.8% followed by Southern Africa at 45.1%, Western Africa with 36.8% while Eastern Africa has 33.8% respectively. North Africa met the Sustainable Development Goals (SDGs) target of a poverty rate below 3% in 2019. Africa's poorest country, South Sudan recorded at rate about 80%, Burundi, Madagascar, the Central African Republic and Democratic Republic of the Congo had extreme poverty rates above 70% in 2019. African countries like Morocco, Algeria, Tunisia, Seychelles and Mauritius, had extreme poverty rates below 1% in 2019. Egypt, Cabo Verde and Libya have met the SDG's target. In 2015 the United Nations adopted the Sustainable Development Goals (SDGs) as a blue print for world peace and prosperity targeting poverty, health, education, economic growth, climate actions among others that member countries agreed to achieved by 2030. However with the pandemic that worsen the situation, Africa is not likely to meet the SDG-1 to end poverty in all its forms for 79% of its population. However, nine countries – Egypt, Cabo-Verde Gabon, Tunisia, Seychelles, Mauritius, Algeria, Morocco and Libya will meet the SDG's target by 2030, 24 countries will still have more than 30% of their population living in extreme poverty. By 2043, Africa will still be struggling to meet the 2030 MDGs; African's Unions (AU) agenda. 17.8% population of the continents will still be in extreme poverty with seven (7) African countries still having extreme poverty rates above 30% by 2043 (Enock and Jacobus, 2022).

Causes of Poverty in Africa

1. Corruption and Weak Governance: With improved good governance, poverty can be reduced to the bearest minimal. Poverty in Africa is also caused by poor infrastructure, poor health services, inadequate roads, energy and health care systems disrupt economics and displace people.
2. Climate Change and Environmental Degradation: Physical qualities such as land use, soil type, elevation, poor land utilization, land tenure system, as well as demographic and income inequality explain more than half of the variation in rural poverty. However, in Africa, these combinations

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026365

vary from province to province. It is characterized by lack of participation in decision making in civil, social and cultural life. (World Bank, 2021).

3. World Bank and IMFs Policies: Critics argue that the IMF's policies often exacerbate poverty and inequality in Africa. The IMF's austery measures such as cutting public spending and increasing taxes can have devastating effects on health care, education and social welfare. IMF's polities have led to cuts in public sector bills thereby affecting essential services (Action Aid Reports, 2023). E.g Austery measures – removing or reducing subsidies on essential fuels or fools, increase tax, reducing salary and pension reform often reducing benefits.
4. Diseases: Prevalence of disease such as malaria, HIV/AIDs, tuberculosis, Ebola, COVID-19 etc. due to inadequate and poor health facilities is another cause of poverty in Africa (MOHAC Africa, 2026). The average life expectancy in Africa stands at 64.2 years, figure pulled from United Nations projections and WHO data updated in 2025.
5. Civil wars and Political Conflicts:- Scares away foreign investors, poor infrastructural set-up e.g. roads, electricity or power, water, transport system etc. which often disrupt economics and displace people.
6. Africa's high population rate resulting from high fertility rate thereby causing a rise in smaller per capital income (ISS, 2022).
7. Climate change: Disasters like flooding and draught are experience in most African countries due to the effect of climate change.

Poverty in Nigeria

Nigeria's poverty exceeds World Bank projection. According to the Nigerian bureau of statistics (NBS) (2022) about 133 million of Nigerians are poor with five state leading. These five states are state mostly affected by banditry, kidnapping, cattle rustling etc. Infact, poverty is really biting hard in Nigeria. NBS Report 2023: Nigeria's 133 million poor people recipe for disaster, IHRC warns. The International Human Rights Commission, (IHRC) (2022) has also raised the alarm over the recent report by the NBS which states that the country is now home to 133 million poor people, saying the nation's economic situation is a recipe for crisis. The global right commission stressed the need for the government to rethink its empowerment programme for the citizens especially those living in the rural areas with the view to cushioning any looming crisis brought about by inflation and mass hunger. The Head of Diplomatic Mission in Nigeria (IHRC) Dr. Duru Hezekial said "we are really in an economic crisis and if it is not checked a time is coming when the country will slide into a state of a fiasco (danger). A time when in fact Nigeria will be declared a "hunger, country and that is why we are appealing to the government: He further said "we believed in dialogue and negotiations not riots. He further stated that poverty might not be eradicated 100 percent but the growth of a nation begins with the growth of its people. If the people are happy and adequately take care of, there will be growth". Looking at the developed countries reveals a low rate of poverty, so the government should empower the vulnerable people (women, children and person with disabilities) to cope with the country's high level of inflation.

Causes of Poverty in Nigeria

1. **Naira Redesign Policy/Naira Swap**: The shortage of currency in Nigeria also contributed to increase in poverty which result into smaller and medium businesses to ground down, transportation fares sky rocketed level of insecurity increases. The Nigeria Economic Summit Groups told Central Bank of Nigeria (CBN). "To allow old and new naira to circulate side by side for now" (NESG, 2023).

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026365

2. **Diseases**: Diseases like malaria, typhoid, fever, HIV/AIDs, T.B, Ebola, COVID-19 have their adverse effect on the economic situation in Nigeria up till now, the government of Nigeria has not fully recovered from COVID-19 Pandemic while other countries have moved on. Diseases like Polio tuberculosis, laser fever, cholera, Diphtheria are still prevalent.
3. **Rising Inflation Worsening, Causing Poverty**: The Lagos chamber of commerce and industry (LCCI) warns Federal Government on the looming crisis of inflation in the country as this leads to high products costs as well as production cost (LCCI, 2023). As at July 2023, inflation hits 22.7% and as at August inflation rises to 25.80% (NBS, 2023).
4. **Fuel Subsidy Removal**: Fuel subsidy removal pushed inflation to 22.79% in July, Naira depreciates to ₦825-1000 per $, petrol prices jump 15% in major cities , as independent marketers sell fuel above ₦600 per litre (Channels TV News, 2023). The rise in petrol forces movement of people and goods to be reduced to the bearest minimal as petroleum price sky rocketed. At the 1st half 2023 of the (Bola Ahmed Tinubu's Administration) there is 15.5% reduction in fatalities, 14% decrease in road crashes and 14% decrease in number of injured victims (FRSC, 2023).
5. **Insecurity**: Economic activities should be redirected to the forest (Sambisa, Dogon Daji) as well as rural areas to curb insecurity.

Impact of Poverty

- **Inflation, Hunger, Malnutrition**: The former president of Nigeria blames food insecurity on policy inconsistency by the government (Obasanjo, 2023). As at June-August 2023, Nigeria has 25 million hunger and malnutrition crisis with 26 states affected and the FCT. The federal government of Nigeria has in its effort to reduce hunger, malnutrition, declared the state of emergency on food security. The president in his efforts directs that grains and fertilizers should be released to farmers in the 36 states of the federation. Impact of emergency on food security are among others. (i) To bring all hands on desk (all stakeholder) towards achieving a common goals.; (ii) The agricultural sectors most have an increase in its budgetary allocation (iii) Policies must be implemented: (iv) To curb insecurity (v) It brings about coordination of efforts.

The FGN (2023) in its efforts also approve the establishment of infrastructural support fund (ISF) for state governors in the 36 states as palliative measures to reduce poverty brought about by inflation. The ISF in the states will intervene and invest in critical areas of transportation, agriculture (ranching solutions), road, railways, other areas of intervention include health, power, water, economic competitions, job creation etc. These was discussed at the National Executive Council meeting chaired by vice president, Kashim Shettima.

1. **Insecurity**: crime and other social vices: poverty eradications will reduce insecurity by 50% (FGN, 2023). Crime rate, conflict and violence in Nigeria owe their roots/origin to lack of unemployment. The increase in youth unemployment and with the current poverty level in the midst of plenty a large number of hungry and angry youth are created from where armed robbery, assassins, kidnapping for ransoms, drug dealers/addiction other social vices evolve. The security challenges affect the economy by depriving individual to go into their economic activities and even drove away foreign investor. For example Boko Haram Insurgency in the North-West, farmer/herdsmen clashes in North-Central (Benue and Plateau). Also the rising rates of divorce, female headed single parent families', teenage pregnancy, drug/alcohol use and other criminal activities have a negative impact on the attitudes and values of a family and communities. These attitudes are passed onto subsequence generations leading to a vicious cycle of poverty (Rodgers, 2000). The infrastructure support fund (ISF) will among others, intervene in health sector, power, water,

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026365

economic competitiveness and also job creation to reduce poverty and its effects on the Nigeria citizens.

2. **Tension and Elevated Agitation**: A hungry man is an angry man. Historical evidences shows that there is a link between food prices social unrest and even revolution. There is also a link between food price and violent/riots. These was evident during the global food crises of 2007/2008 when food prices promoted riots across several countries of the world (Berrazneva, and Lee, 2013; Navarro, 2017). The CBN governor in press briefing says one of the challenges of poverty is tensions and agitation (Godwin, 2023). Agitation in Nigeria's South-East brought about by indigenous people of Biafra's (IPOB) demand, agitation for justice and fairness by the South-East, facilitated by Nnamdi Kano.

The Russia-Africa Summit: The Russia-Ukraine War

Following the withdrawal of the Russians from the black sea grain deal where grains, like, rice, and wheat. are cultivated in exported. Prof. Isaac Mbachu Head, Defence and security studies NDA Kaduna says, African countries will suffer 2nd food insecurity for Russia to withdraw from black sea grain deal (Isaac, 2023). In view of this the Russian president Vladymir Putin offers free grains to African leaders on Thursday 27, July 2023 at Petersburge, Russia during the African Russia summit. The summit ends with resolutions to enhance cooperation in trade, security, ICT and in other areas (Russia-Africa Summit 2023).

Ways Forward: Agricultural revolution could push over 110 million people out of extreme poverty by 2043. (Enoch and Jacobus, 2022)

1. **The role of Biotechnology in socio-economic development in Nigeria**: In Nigeria five (5) technical department were created to bring out the small numbers of companies by the National Biotechnology Development Agency (NABDA). They are those of agricultural technology, Environmental technology, food and pharmaceutical technology, Gene and Genome technology, Biosafety technology as well as medical technology. The essence is to increase more people into farming, more food for food security, Job creation, food processing to (reduce wastage and shortage) pest resistance crops, drought resistance plants with high yields and Eco-friendly crops, Gene/Genome editing etc. (Abdullahi, 2023). Agricultural Biotechnology holds promise of effectiveness in increasing crop yields, reduce the need for chemical pesticides improving health by introducing desirable nutritional characteristics into new varieties.
2. **Agricultural Mechanization**: Widely used globally equipment must be use, these includes basic tools like tractors, controlled machines (which monitors work, time, growth, pest control etc). Also commercialized farming where farmers are encourage to form cooperatives, associations to assess funds and loans (Oluremi, 2023).
3. **Small/Medium Scale Business**: Government should open-up small/medium business should encourage it to grow and expand provide enable environment for industries, companies to grow and expand as these will support job creation/opportunities. In Nigeria many small businesses earn below N223.259 monthly- (NBC, 2023)
4. **Hydrosponic Farming**: Plants generally require five (5) basic things i.e food (nutrients) H_20, O_2, light and support. Plants can thrive well either indoor or outdoor if these basic things are present. Hydroponic farming is an amazing science, it helps in cultivations of fruits, vegetables which are bacteria and virus free it can be used where space constraints are large, hydroponics also called Nutri culture, soil less culture or tank farming involves the cultivation of plants in a nutrient enriched H2O or without the mechanical support of an inert medium ie sand or graved. The nutrients used can be gotten from fish excrement, duck manure, purchase chemicals, fertilizer or artificial nutrient. The resources are built of plastics, concrete, vegetable solids, wood etc. the

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026365

containers can be placed on ground or on the table (Jones, 2004) plants commonly grown include tomatoes, pepper, cucumber, potatoes, lettuce, straw berries, herbs etc (Suryawanshi, 2021).

Advantages

1. It has minimal ecological and environmental pollution.
2. Saves labour (automatic water and fertilizing)
3. Less nutrient competition (plants have less root)
4. Fewer pests and diseases
5. It is an all year growing cycle
6. It can be set indoors

Disadvantages

1. It has a high installation cost
2. It is vulnerable to power outage or equipment failure
3. The solution (nutrient) must be tested frequently

An example of this system of farming is found in Jigawa state-ALU Agro Allied farms, Nigeria.

Fish Farming: cat fish industry is a revolution in farming. Over 200million around the world are involved in fish farming. Local, small and medium enterprises are involved. Nigeria are into cat fish farming, Ghana practice Tilafia and Malawi are into catfish farming as well as fingerlinges hatching. These industries serves to promote jobs creation in areas of packaging and selling of fish, fish harvesting, Hatching of fingerlings, fish food production and processing etc. The Eriwe fish farm village, Lagos. Is an example in Nigeria. Other areas include vegetable farming where crops like oranges, Apples, fruits vegetables are produced in large quantities by small farmers example of vegetable farming is in Jos, Nigeria. Achieving food security to achieve food security in Nigeria, will inturn reduce poverty, the National Biotechnology Development Agency (NABDA) encourages and produce high quality seeds and the availability (seeds with high yields, rest resistance. Also to curb insecurity, seeds with high yields occupying small space example cowpea and maize are available. (i) Soil quality must be checked (ii) Climate change-draught resistance seeds as well as flood resistance crops (plants can stay under for 2 weeks-rice seeds).

Conclusion

The world population is expected to exceed 8 billion by 2025, an increase of 2.0billion in the next 25years. Much of these will occur in developing countries. There will be many more mouths to feed in complex circumstances. This increase must come primarily from increasing biological yields not from area expansion and more irrigation because land and water are becoming increasingly-scarce. The word of science has grown and changed beyond most expectations. Today, a revolution is taking place in the biological sciences. It is fuelled by the ground breaking work in modern molecular genetics and the enormous sums beings invested in biotechnology research. A report published by a one campaign (an-anti poverty group) reveals that the three significant forms of financing for African countries is official development assistance, domestic revenues and foreign direct investments which have declined since 2012. Africa's population is set to double by 2050, this presents us with two scenarios- one Africa has a larger workforce and becomes the emerging engine of the global economy. Two, millions of young people lack employment and skills they become frustrated and migrate or fall under the hands of extremists. Agitation leads to violence, killings (Security personnel inclusive), ambushing and burning of public and private facilities resulting into loss of billions of resources driving the people into extreme poverty. The minister of Humanitarian Affairs and poverty alleviation

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026365

in Nigeria says poverty can be reduced by geographical mapping of the poor (people living under 1$ per day) and community targeting (community heads & religion leaders must be involved).

1. Awareness to the community through the National Orientation Agency (NOA)
2. Creation of Humanitarian Hob in each of the 774 LGA's in the country.
3. Trading of the farmers with the rest of the world
4. Presidential trust fund should be sourced from public, Private, Donor Agencies, Foundations and United Nations.
5. Implementation of these strategies must be taking down to the Grassroots and with sincerity of purpose (Betta, 2023).

Lastly, "Africa is not a continent to be-pitied" president Bola Ahmed Tinubu stated this at the 78th United Nations General Assembly but rather to be supported. At the Assembly, world leaders call for more attention on Global Economy, climate changes, hunger, gender issues, Education, job creation, poverty reduction and others (UNGA, 2023). Also in his address at the Nigeria's 63rd independent anniversary, the president vows to crush Terrorism and poverty in Nigeria.

Summary of Finding

Out of the 54 African countries of the world 10 countries are ranked as the most poorest- thy are Burundi, Somalio, CAR, Dr Congo, Niger, Madagascar, Chad, Mozambigue, Liberia, Malawi by the Gross National income (GNI) Per capital.

Recommendations

1. Establishment of biotechnology centres in all the six geopolitical zones, to enable conduct more research on the most commonly grown crops in their region.
2. Local Government system must be resuscitated in Nigeria as they are directly in torch with the grass roots.
3. Traditions leaders/rulers must be involved in conflicts resolution within the communities.
4. Issues of infrastructural deficit must be addressed (electricity supply, roads, railways) etc.
5. Resuscitation of companies like Ajaokuta steel company, NNPC with Naira transaction within and outside the country.
6. Economic freedom-African countries must be allowed to trade/transact businesses with then currencies.
7. Developmental Aids to African countries should increase.
8. There should be more partnership between the developed countries and developing countries/nations.
9. Bringing the sustainable Development Goals back to tract to enable most African countries meet its target and goal.
10. Negotiation and Re-assurance of the African countries with foreign investors.
11. Tackling insecurity with utmost sincerity also tackling climate change (afforestation) & reducing pollution.

References

Abdullahi, M. (2023). The role of biotechnology in socio-economic development platform: *NTA News* 24 fn/03/2023 www.nta.ng.org

Action Aid Reports (2020). IMF and held bank policies, including "fifty years of failure: The IMF, Debt and Austenly in Africa. actionaid.org

Beraznera, J. & Lee, D.R. (2013). Explaining the African food riots of 2007-2008. An empirical analysis. *Food policy,* 39: 28-39 do: 10-10161) food pol, 2012. 12-002.

Betta, E. (2023). The Big challenge of trackling poverty in Nigeria. Democracy today. AIT News Mon 25/Sept. www.ait.live

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026365

Channels TV (2023). Fuel subsidy removal: Channels TV news.

Dasgupta, P (2021). The economic of biodiversity: Th Dasgupta Review. HW Treasury

Enoch, R.A. & Jacobus, D.M. (2022). African futures and innovation institute for security studies, ISS Pretoria www.issafrica.org

Eze, E. & Alugboo, J.C. (2021). Financial inclusion and poverty reduction in Nigeria: A survey based analysis. GSC Advanced research and Reviews, 7(3), 075-084.

Ezema, C.J. & Orji, L.D. (2025). Financial inclusion and poverty reduction in Nigeria: An autoregressive distributed LAG model approach. EBSU journal of social sciences and humanities 15(1).

Federal Government of Nigeria (2023). Ibrand TV News headlines Thr 07/09/2023

Federal Government of Nigeria (2023). National Executive Council meeting NTA News 24 Friday July 21.

Federal Government of Nigeria (2023). News Headlines Kaftan TV News, 26 July

Federal Road Safety Corp (2023). FRSC 2023 Report. Business News.

Godwin, E. (2023). Challenges of poverty in Nigeria Press briefing: Badeggi FM Radio. Feb 15.

International Human Rights Commission (2022). NBS Report: Nigeria's 133 million poor people, recipe for disaster – News.

Isaac, M. (2023). Russia withdrawal from black sea grain deal crisis negative impact on 3rd world countries channels TV News Tuesday 18 July.

Jones, Jr. J.B. (2004). Hydroscopic A. Practical guide for the Soilless Grower (2nd ed) Buca ration, London, New York, Washing D CRC Press Pp. 153-166 ISBN 9780849331671

Lagos chamber of commerce and industry (2023). Rising inflation in Nigeria Ibrand TV News Monday 20 Feb May.

Millennium Development Goals (2015). United Nations MDG Report 2015: Highlight progress and outcomes of the MDG's.

MOHACAFRICA (2026). Life expectancy in Africa 2026: stats, causes and gains. mohacafrica.org

National Bureau of Statistics (2022). 2022 multi-dimensional poverty index Survey (MPI). www.nigerianstat.gov.ng

National Economic Summit Group (NESG) (2023). Naira redesign policy Ibrand TV News 20/02/2023

Nigerian Bureau of Statistics (NBS, 2023). Business express – NTA News Friday 15/09/2023.

Nouaru, R.L (2017). Food security. A requisite to national security. Business mirro. Retrieved from https://businessmirror.comph/2017/05/05/food-security-a-arequisite Ph.D H PAMPE to national security

Obasanjo, O. (2023). Food insecurity in Nigeria channels News headline 18/07/2023.

Oluremu, P. (2023). Farm mechanization and practices: Green 360 Ibrand TV Friday 21/07/2023

Rodgers, H.R. (2000). American poverty in a New Era of Reform. New York M.E. Sharpe.

Russia-Africa Summit (2023). Africa-update trust TV news 2023/07/27 www.trustTv.com

Suryawanshi, Y. (2021). Hydroscopic cultivation approaches to enhance the contents of the secondary metabolites in plants biotechnological approaches to enhance plant secondary metabolites CRC press: 71-88.

United Nations General Assembly (2023). 78th United Nations General Assembly meeting New York.

World Bank (2021). World Development Report; focuses on data driven decision making for development.

World Bank (2026). Finance in Africa: deepening poverty repent Nigeria must confront. This day live.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026366

Differential Amelioration of Aminoglycoside-Induced Oxidative Stress by Virgin Coconut Oil in the Vestibulocochlear Tissue and Serum of Wistar Rats

MUSAH, Ibrahim[1]
drladz440@gmail.com/imusah@abu.edu.ng
Tel:+2348036193361
ISA, Ahmed-Sherif[1]
ALHASSAN, AbduWahab[1]
EMMANUEL, Nachamada Sincliar[1]
DOGARA, Kabir Jibril[1]
UMAR, Zainab[2]
[1]Department of Human Physiology, Faculty of Basic Medical Sciences, College of Medical Sciences, Ahmadu Bello University, Zaria.
[2]University Health Services, Ahmadu Bello University, Zaria.

Abstract

Aminoglycoside (AG)-induced ototoxicity is primarily driven by the generation of reactive oxygen species (ROS) within the inner ear, leading to irreversible hair cell damage and death. Virgin coconut oil (VCO) is a natural product with potent antioxidant properties, but its specific effect on ROS levels within the vestibulocochlear tissue was unexplored. This study investigated the differential effects of VCO on concentrations of total ROS and inflammatory cytokine in the vestibulocochlear tissue and serum of rats treated with gentamicin (GTM). Thirty male Wistar rats were divided into six groups (n=5): normal control, GTM-only (80 mg/kg i.p.), GTM + Vitamin E (20 IU/kg, p.o.), and three GTM + VCO groups (1, 5, and 10 ml/kg, p.o.). Treatments were for 30 days, following which animals were sacrificed and serum and vestibulocochlear tissue homogenates were collected and assessed for total ROS, interleukin-1β (IL-1β), and tumor necrosis factor-alpha (TNF-α) using enzyme-linked immunosorbent assay (ELISA) kits. GTM treatment significantly elevated total ROS concentrations in both the vestibulocochlear tissue (146.02 ± 15.95 µg/mL) and serum (107.50 ± 1.29 µg/mL) compared to controls (tissue: 125.19 ± 2.68 µg/mL; serum: 87.49 ± 4.38 µg/mL; $p < 0.05$). Co-administration with VCO at all doses (1, 5, and 10 ml/kg) significantly reduced tissue ROS levels below control values ($p < 0.05$), with the 5 ml/kg dose being the most effective (83.59 ± 2.92 µg/mL). VCO was found to exert dose-dependent antioxidant effect on total ROS and TNF-α. These findings provide a biochemical basis for VCO's otoprotective effects al as a therapeutic adjuvant during AG therapy.

Keywords: Aminoglycoside, Gentamicin, Ototoxicity, Virgin Coconut Oil, Reactive Oxygen Species, Oxidative Stress, TNF-α, Antioxidant.

Introduction

Aminoglycoside antibiotics, particularly gentamicin, remain indispensable in clinical practice for the treatment of severe gram-negative infections and multidrug-resistant tuberculosis (MDR-TB), especially in resource-limited settings like rural Nigeria (Frymark *et al.*, 2010; Heysell *et al.*, 2018). However, their use is significantly hampered by often irreversible nephrotoxicity and ototoxicity, affecting both cochlear and vestibular function in a substantial proportion of patients (Modongo *et al.*, 2015; Rizk *et al.*, 2020; Selimoglu, 2007). The pathogenesis of aminoglycoside-induced ototoxicity is complex but is now understood to be critically dependent on their accumulation in the mitochondria and the subsequent generation of reactive oxygen species (ROS). Gentamicin enters hair cells via mechanoelectrical transducer channels (Marcotti *et al.*, 2005) and accumulates within mitochondria, where it forms redox-active complexes with iron (e.g., Fe^{2+}-gentamicin). These complexes catalyze the Fenton reaction, generating highly damaging ROS such as superoxide anions, hydrogen peroxide, and hydroxyl radicals (Clerici *et al.*, 2005; Fu *et al.*, 2021; Schacht *et al.*, 2012).

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026366

This oxidative stress overwhelms the intrinsic antioxidant defenses of hair cells, leading to mitochondrial dysfunction, activation of apoptotic pathways (e.g., via caspase-3 and c-Jun N-terminal kinase [JNK]), and ultimately, cell death (Huth *et al.*, 2011; Wei *et al.*, 2005). In addition to direct oxidative damage, gentamicin can also trigger inflammatory responses, with some studies implicating cytokines like tumor necrosis factor-alpha (TNF-α) in the ototoxic cascade (Fu *et al.*, 2021; Hirose & Liberman, 2003). Given the central role of oxidative stress, the search for effective antioxidant otoprotectants has been a major research focus. Agents such as D-methionine, N-acetylcysteine, and various polyphenols have shown promise in preclinical models (Campbell *et al.*, 2016; Fetoni *et al.*, 2012; Sha & Schacht, 2000). Virgin coconut oil (VCO), an unrefined oil extracted from fresh coconut kernels, has emerged as a potent natural antioxidant. It is exceptionally rich in medium-chain fatty acids (especially lauric acid) and polyphenolic compounds, which have demonstrated the ability to scavenge free radicals, reduce lipid peroxidation, and enhance the activity of endogenous antioxidant enzymes like superoxide dismutase and catalase (Arunima & Rajamohan, 2014; Nevin & Rajamohan, 2006; Zekrumah *et al.*, 2023). While VCO has shown neuroprotective effects in other models (Alghamdi, 2018; Rahim *et al.*, 2017), its specific impact on ROS generation directly within the vestibulocochlear tissue, has not been investigated. The present study was designed to elucidate a possible biochemical basis for VCO effect on oxidative stress burden within the inner ear. Therefore, we measured the concentrations of total ROS, along with the pro-inflammatory cytokines IL-1β and TNF-α, in both the vestibulocochlear tissue and serum of male Wistar rats following chronic gentamicin exposure, with and without VCO co-administration. This allowed us to assess the differential effects of VCO within the inner ear versus its systemic anti-inflammatory and antioxidant actions.

Materials and Methods

Ethical Approval

All experimental procedures were in accordance with the Ahmadu Bello University Committee on Animal Use and Care (Approval Number: ABUCAUC/2023/066) and conducted in accordance with international guidelines for the care and use of laboratory animals.

Animals and Experimental Design

Thirty (30) male Wistar rats (initial weight range: 79-141 g) with normal startle reflex were obtained from the animal house of the Department of Human Physiology, Ahmadu Bello University, Zaria. They were housed under standard conditions with *ad libitum* access to feed and water and allowed to acclimatize for two weeks before commencement of the experiment. Rats with good startle reflex were selected and randomly assigned to six groups (n=5 per group).

Table 1: Experimental Design

Groups	Treatment
Normal Control Group	Normal saline only group
Gentamicin Only group	Received gentamicin (80 mg/kg, i.p.) daily
GTM +VCO1	Received VCO (1 ml/kg, p.o.) and gentamicin (80 mg/kg, i.p.)
GTM +VCO5	Received VCO (5 ml/kg, p.o.) and gentamicin (80 mg/kg, i.p.)
GTM +VCO10	Received VCO (10 ml/kg, p.o.) and gentamicin (80 mg/kg, i.p.)
GTM + Vit E	Received Vit E (20IU/kg, p.o.) and gentamicin (80 mg/kg, i.p.)

All treatments were administered daily for 30 consecutive days. VCO was given by oral gavage at 10:00 am, followed by intraperitoneal gentamicin at 12:00 noon to control for circadian variations in toxicity (Signh *et al.*, 2005; Blunston *et al.*, 2015; Rahim *et al.*, 2017; Cao *et al.*, 2019).

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026366

Preparation of Virgin Coconut Oil

VCO was extracted from mature coconut kernels using a cold-process fermentation method as previously described (Nevin & Rajamohan, 2004; Yusuf *et al.*, 2016). Briefly, coconut endosperm was blended into a viscous slurry and squeezed through a cheesecloth to obtain coconut milk. The milk was refrigerated for 48 hours, then allowed to thaw at room temperature. The separated oil was collected, vigorously stirred to remove residual water, and filtered to obtain the final VCO product used for administration.

Sample Collection and Preparation

At the end of the 30-day treatment period, all rats were anesthetized with an intraperitoneal injection of ketamine (75 mg/kg) and diazepam (5 mg/kg) (Molina *et al.*, 2015). Blood samples were collected via cardiac puncture into plain bottles, allowed to clot, and centrifuged at 3000 × g for 10 minutes to separate serum, for biochemical analysis. Following blood collection, the animals were decapitated, and the left temporal bone was dissected. The thin, bulbous area of the mastoid bone containing the cochlea and vestibular apparatus (the vestibulocochlear organ) was carefully harvested as described by Neal *et al.* (2018). The tissue was rinsed in ice-cold saline, blotted dry, weighed, and homogenized in a suitable buffer. The homogenate was centrifuged, and the supernatant was collected for analysis.

Biochemical Assays

Concentrations of total ROS, interleukin-1β (IL-1β), and tumor necrosis factor-alpha (TNF-α) in both serum and vestibulocochlear homogenates were quantified using commercial rat enzyme-linked immunosorbent assay (ELISA) kits according to the manufacturer's instructions. The kit specifications were as follows: i) Total ROS (Cat. No. CK-bio-20410): Standard curve range 20-800 µg/mL, sensitivity 1.0 µg/mL, ii) IL-1β (Cat. No. CK-bio-15468): Standard curve range 5-300 pg/mL, sensitivity 1.0 pg/mL, and iii) TNF-α (Cat. No. CK-bio-15469): Standard curve range 10-320 pg/ml, sensitivity 1.0 pg/ml.

Data Analysis

Data were analyzed using SPSS software (version 23.0). All values were expressed as mean ± standard error of the mean (SEM). Comparisons between multiple groups were performed using a one-way analysis of variance (ANOVA), followed by Tukey's *post-hoc* test for multiple comparisons. A value of $p < 0.05$ was considered statistically significant.

Presentation of Results

Effect of VCO on Vestibulocochlear Tissue ROS

The concentration of total ROS in the vestibulocochlear homogenate is shown in Figure 1. Chronic gentamicin administration in the GTM-only group resulted in a significant elevation of tissue ROS (146.02 ± 15.95 µg/mL) compared to the normal control group (125.19 ± 2.68 µg/mL, $p < 0.05$), confirming the induction of local oxidative stress. Remarkably, co-administration of VCO in all three treatment groups not only prevented this rise but reduced tissue ROS concentrations to levels significantly below those of the normal control group ($p < 0.05$ for all VCO groups vs. control). The mean ROS concentrations were 102.51 ± 2.58 µg/mL for GTM+VCO1, 83.59 ± 2.92 µg/mL for GTM+VCO5, and 101.94 ± 5.97 µg/mL for GTM+VCO10. The reduction was most pronounced in the GTM+VCO5 group, which was also significantly lower than the GTM+VCO1 and GTM+VCO10 groups ($p < 0.05$). In contrast, the GTM+Vit E group showed a significantly elevated tissue ROS concentration (151.17 ± 4.67 µg/mL). This was significantly higher than both the normal control group ($p < 0.001$) and the GTM-only group ($p < 0.05$), and was also significantly greater than all VCO-treated groups ($p < 0.001$).

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026366

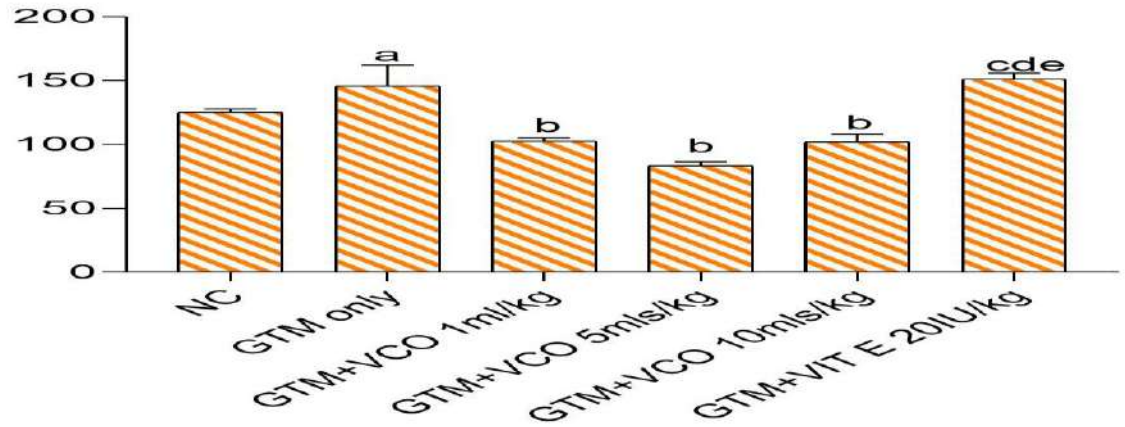


Figure 1: Results showing mean vestibulocochlear tissue ROS concentration (µg/mL) against the six experimental groups. Error bars represent SEM. Significant differences between groups are indicated by different letters ($p < 0.05$).

Effect of VCO on Serum ROS

The pattern of ROS modulation in the serum (Figure 2) was similar but not identical to that seen in the tissue. The GTM-only group had significantly elevated serum ROS (107.50 ± 1.29 µg/mL) compared to the normal control (87.49 ± 4.38 µg/mL, $p < 0.05$). The GTM+VCO5 (86.87 ± 0.73 µg/mL) and GTM+VCO10 (82.56 ± 6.61 µg/mL) groups both showed significantly reduced serum ROS concentrations compared to the GTM-only group ($p < 0.05$) and were comparable to the normal control. The GTM+VCO1 group had a mean serum ROS of 95.75 ± 1.64 µg/mL, which was not significantly different from the control or GTM-only groups ($p > 0.05$). The GTM+Vit E group also showed a significant reduction in serum ROS (83.26 ± 2.96 µg/mL) compared to GTM-only ($p < 0.05$), contrasting with its effect in the tissue.

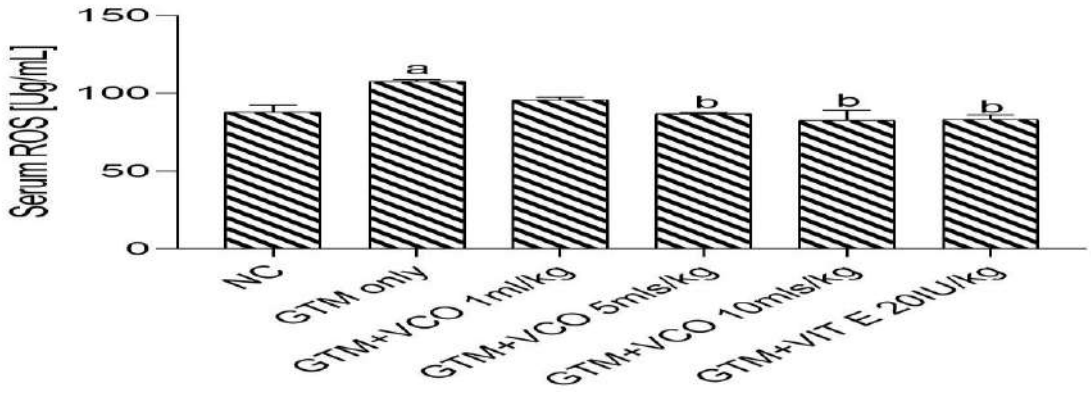


Figure 2: Results showing mean serum ROS concentration (µg/mL) against the six experimental groups on the X-axis. Error bars represent SEM. Significant differences between groups are indicated by different letters p (< 0.05).

Effect of VCO on Inflammatory Cytokines

TNF-α Concentrations

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026366

The effects on TNF-α are presented in Figure 3 (serum) and Figure 4 (tissue). In the serum, gentamicin induced a marked and significant inflammatory response. The GTM-only group had a mean TNF-α concentration of 258.27 ± 24.91 pg/ml, which was more than double that of the normal control group (119.37 ± 10.15 pg/ml, $p < 0.001$). This systemic increase was significantly attenuated by VCO co-administration. The GTM+VCO5 (132.09 ± 12.60pg/ml), GTM+VCO10 (96.78 ± 6.43 pg/ml), and GTM+Vit E (102.18 ± 9.36 pg/ml) groups all had serum TNF-α levels significantly lower than the GTM-only group ($p < 0.01$) and not significantly different from the normal control. In the vestibulocochlear tissue, however, the pattern was different. While the GTM-only group showed a trend towards elevated TNF-α (121.18 ± 7.95 pg/ml) compared to the control (100.88 ± 6.49 pg/ml), this difference did not reach statistical significance ($p = 0.08$). All VCO and Vitamin E-treated groups had tissue TNF-α levels comparable to the control group.

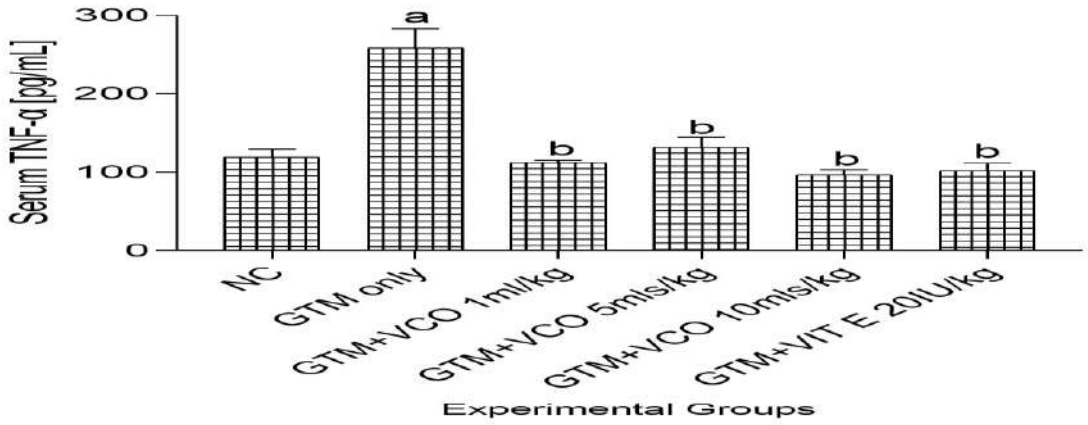


Figure 3: Results for serum TNF-α (pg/ml). Superscripts with different letters indicate statistical significance ($p < 0.05$).

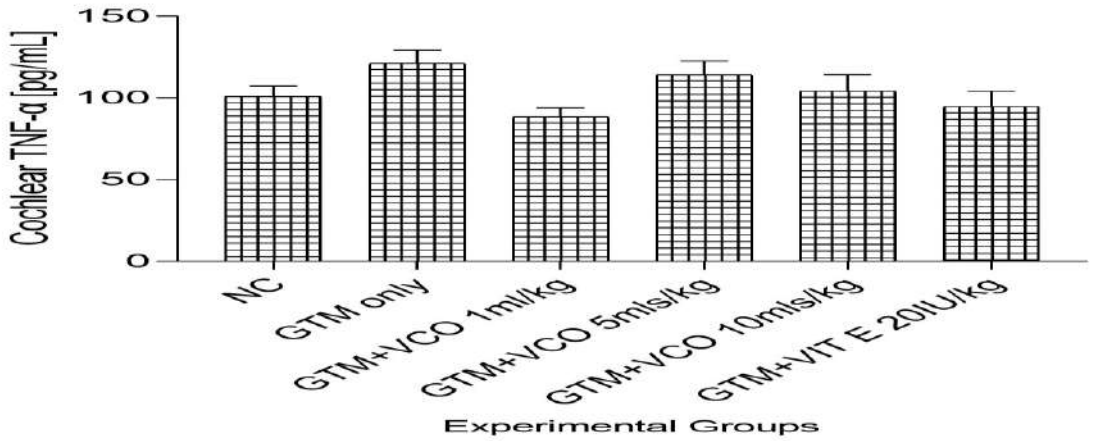


Figure 4: Results for Vestibulocochlear tissue TNF-α (pg/ml).

3.3.2 IL-1β Concentrations

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026366

There were no statistically significant differences in IL-1β concentrations between any of the treatment groups, either in the serum or in the vestibulocochlear tissue ($p > 0.05$ for all comparisons). The data are summarized in Table 2.

Table 2. Serum and Vestibulocochlear Tissue IL-1β Concentrations

Group	Tissue **IL-1β** (pg/ml)	Serum **IL-1β** (pg/ml)
Normal control group	2.76 ± 0.10	3.42 ± 0.48
Gentamicin Only group	2.98 ± 0.14	2.69 ± 0.24
GTM + VCO 1ml/Kg	2.74 ± 0.09	2.79 ± 0.11
GTM + VCO 5ml/Kg	2.74 ± 0.11	2.88 ± 0.22
GTM + VCO 10ml/Kg	3.18 ± 0.13	2.69 ± 0.11
GTM + Vit E 20IU/kg	2.95 ± 0.27	2.96 ± 0.17

Values are mean ± SEM. No significant differences were found between any groups ($p > 0.05$)

Discussion of Findings

This study provides some biochemical evidence supporting the otoprotective role of virgin coconut oil against gentamicin-induced damage. Our findings demonstrate that VCO exerts differential antioxidant effects, significantly reducing ROS accumulation within the vestibulocochlear tissue the primary site of ototoxic injury, while also mitigating systemic oxidative stress and inflammation. The significant elevation of total ROS in both the vestibulocochlear tissue and serum of the GTM-only group is entirely consistent with the established mechanism of aminoglycoside ototoxicity. Gentamicin is known to generate ROS via iron-chelate complexes within mitochondria, overwhelming local antioxidant defenses and triggering apoptotic hair cell death (Clerici *et al.*, 2005; Fu *et al.*, 2021; Huth *et al.*, 2011; Schacht *et al.*, 2012). Our results confirm that a 30-day course of gentamicin at 80 mg/kg is sufficient to induce a state of chronic oxidative stress in the inner ear. This study demonstrated a significant reduction of vestibulocochlear tissue ROS by VCO. All three doses of VCO not only prevented the gentamicin-induced rise in ROS but actually lowered ROS concentrations significantly below levels of the control group. This suggests that VCO possesses a potent and direct antioxidant capacity within the cochlear and vestibular microenvironment. This aligns with the known properties of VCO, which is rich in polyphenolic compounds (e.g., gallic acid, ferulic acid) and medium-chain fatty acids that can act as direct free radical scavengers (Marina *et al.*, 2009; Nevin & Rajamohan, 2006; Zekrumah *et al.*, 2023). Furthermore, VCO has been shown in other organ systems to upregulate the expression of endogenous antioxidant enzymes such as superoxide dismutase, catalase, and glutathione peroxidase, thereby enhancing the tissue's intrinsic capacity to neutralize ROS (Arunima & Rajamohan, 2014; Famurewa *et al.*, 2020). The dose-response relationship, with the 5 ml/kg dose appearing most effective in tissue, may reflect a saturation of uptake or a ceiling effect for certain bioactive compounds within the inner ear. This robust local antioxidant effect provides a clear mechanistic basis for the preservation of auditory and vestibular function we previously observed in these same animals (Musah, 2024). The differential effect of VCO on ROS in inner ear versus serum is noteworthy. While the 1 ml/kg dose significantly reduced tissue ROS, it did not significantly lower serum ROS. This may indicate that the inner ear is more permeable to or accumulates VCO's active components, or that the ROS generated locally in the tissue is more accessible to scavenging by VCO active components or its metabolites. Alternatively, it could suggest that the primary antioxidant action of VCO in this model is a local one, with the reduction in serum ROS at higher doses (5 and 10 ml/kg) being a secondary, systemic effect. The pattern for TNF-α was also differential. Gentamicin caused a dramatic, two-fold increase in systemic (serum) TNF-α, which was effectively normalized by VCO at 5 and 10 ml/kg. This demonstrates a significant anti-

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026366

inflammatory effect of VCO, consistent with reports of its ability to modulate inflammatory pathways, likely by inhibiting the activation of nuclear factor kappa-B (NF-κB) (Intahphuak *et al.*, 2010). However, within the vestibulocochlear tissue itself, gentamicin did not induce a statistically significant rise in TNF-α, and VCO had no measurable effect. This finding suggests that while systemic inflammation may be a component of the broader response to gentamicin, the primary drivers of local ototoxicity are likely direct oxidative stress and perhaps other local inflammatory mediators (e.g., IL-6) or apoptotic signaling pathways (e.g., JNK), rather than a robust local TNF-α response (Eshraghi *et al.*, 2007; Fu *et al.*, 2021). The lack of any change in IL-1β in either compartment further supports the notion that this particular cytokine is not a major player in this model of chronic gentamicin ototoxicity.

Conclusion

This study demonstrates that virgin coconut oil effectively and differentially ameliorates gentamicin-induced oxidative stress. Its most critical action is the dramatic reduction of ROS accumulation directly within the vestibulocochlear tissue, providing a possible biochemical rationale for its functional otoprotective effects. Additionally, VCO mitigates systemic inflammation by lowering serum TNF-α. These findings establish VCO as a promising, accessible adjuvant therapy to combat the debilitating ototoxic side effects of aminoglycoside, particularly gentamicin.

Areas of Limited Evidence / Future Directions

While this study measured total ROS, it did not identify the specific radical species involved or measure the activity of endogenous antioxidant enzymes (e.g., SOD, catalase, GPx) in the tissue. The lack of a significant local inflammatory response (TNF-α, IL-1β) does not rule out the involvement of other inflammatory mediators or apoptotic pathways (e.g., JNK, caspase-3).

Acknowledgment/Funding Statement

I want to appreciate Tertiary Education Trust Fund (TETFund) for the IBR grant given to me for this research, grant number TETF/DR&D/UNI/ZARIA/IBR/2025/BATCH 9/04.

References

Alghamdi, B. S. A. (2018). Possible prophylactic anti-excitotoxic and anti-oxidant effects of virgin coconut oil on aluminium chloride-induced Alzheimer's in rat models. *Journal of Integrative Neuroscience*, 17(3–4), 593–607.

Arunima, S., & Rajamohan, T. (2014). Influence of virgin coconut oil-enriched diet on the transcriptional regulation of fatty acid synthesis and oxidation in rats – a comparative study. *British Journal of Nutrition*, 111(10), 1782–1790.

Blunston, M. A., Yonovitz, A., Woodahl, E. L., & Smolensky, M. H. (2015). Gentamicin-induced ototoxicity and nephrotoxicity vary with circadian time of treatment and entail separate mechanisms. *Chronobiology International*, 32(9), 1223–1232.

Bowry, V. W., & Stocker, R. (1993). Tocopherol-mediated peroxidation. The prooxidant effect of vitamin E on the radical-initiated oxidation of human low-density lipoprotein. *Journal of the American Chemical Society*, 115(14), 6029-6044.

Campbell, K. C., Martin, S. M., Meech, R. P., Hargrove, T. L., Verhulst, S. J., & Fox, D. J. (2016). D-methionine (D-met) significantly reduces kanamycin-induced ototoxicity in pigmented guinea pigs. *International Journal of Audiology*, 55(5), 273–278.

Cao, L., Zhi, D., Han, J., Kumar Sah, S., & Xie, Y. (2019). Combinational effect of curcumin and metformin against gentamicin-induced nephrotoxicity: Involvement of antioxidative, anti-inflammatory and antiapoptotic pathway. *Journal of Food Biochemistry*, *43*(7).

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026366

Clerici, W. J., DiMartino, D. L., & Prasad, M. R. (2005). Direct effects of reactive oxygen species on cochlear outer hair cell shape in vitro. *Hearing Research*, 84(1-2), 30–40.

Eshraghi, A. A., Wang, J., Adil, E., He, J., Zine, A., Bublik, M., … & Van De Water, T. R. (2007). Blocking c-Jun-N-terminal kinase signaling can prevent hearing loss induced by both electrode insertion trauma and neomycin ototoxicity. *Hearing Research*, 226(1-2), 168-177.

Famurewa, A. C., Maduagwuna, E. K., Folawiyo, A. M., Besong, E. E., Eteudo, A. N., Famurewa, O. A., & Ejezie, F. E. (2020). Antioxidant, anti-inflammatory, and antiapoptotic effects of virgin coconut oil against antibiotic drug gentamicin-induced nephrotoxicity via the suppression of oxidative stress and modulation of iNOS/NF-κB/caspase-3 signaling pathway in Wistar rats. *Journal of Food Biochemistry*, 44(1), e13100.

Fetoni, A. R., Eramo, S. L. M., Rolesi, R., Troiani, D., & Paludetti, G. (2012). Antioxidant treatment with coenzyme Q-ter in prevention of gentamycin ototoxicity in an animal model. *Acta Otorhinolaryngologica Italica*, 32(2), 103-110.

Frymark, T., Leech, H., Mullen, R., Schooling, T., Venediktov, R., & Wang, B. (2010). *Evidence-Based Systematic Review: Drug-Induced Hearing Loss-Gentamicin*. ASHA's National Center for Evidence-Based Practice in Communication Disorders.

Fu, X., Wan, P., Li, P., Wang, J., Guo, S., Zhang, Y., … & Chai, R. (2021). Mechanism and Prevention of Ototoxicity Induced by Aminoglycosides. *Frontiers in Cellular Neuroscience*, 15, 692762.

Heysell, S. K., Ahmed, S., Rahman, M. T., Akhanda, M. W., Gleason, A. T., Ebers, A., … & Banu, S. (2018). Hearing loss with kanamycin treatment for multidrug-resistant tuberculosis in Bangladesh. *European Respiratory Journal*, 51(3), 1701778.

Hirose, K., & Liberman, M. C. (2003). Lateral wall histopathology and endocochlear potential in the noise-damaged mouse cochlea. *Journal of the Association for Research in Otolaryngology*, 4(3), 339–352.

Huth, M. E., Ricci, A. J., & Cheng, A. G. (2011). Mechanisms of Aminoglycoside Ototoxicity and Targets of Hair Cell Protection. *International Journal of Otolaryngology*, 2011, 937861.

Intahphuak, S., Khonsung, P., & Panthong, A. (2010). Anti-inflammatory, analgesic, and antipyretic activities of virgin coconut oil. *Pharmaceutical Biology*, 48(2), 151–157.

Kharkheli, E. S., Kevanishvili, Z., Maglakelidze, T., Davitashvili, O. Z., & Schacht, J. (2007). Does vitamin E prevent gentamicin-induced ototoxicity? *Georgian Medical News*, 146, 14-17.

Marcotti, W., van Netten, S. M., & Kros, C. J. (2005). The aminoglycoside antibiotic dihydrostreptomycin rapidly enters mouse outer hair cells through the mechano-electrical transducer channels. *The Journal of Physiology*, 567(2), 505-521.

Marina, A. M., Che Man, Y. B., & Amin, I. (2009). Virgin coconut oil: emerging functional food oil. *Trends in Food Science & Technology*, 20(10), 481-487.

Modongo, C., Pasipanodya, J. G., Zetola, N. M., Williams, S. M., Sirugo, G., & Gumbo, T. (2015). Amikacin Concentrations Predictive of Ototoxicity in Multidrug-Resistant Tuberculosis Patients. *Antimicrobial Agents and Chemotherapy*, 59(10), 6337–6343.

Molina, A., Moyano, R., Serrano-Rodríguez, J., Ayala, N., Lora, A. J., & Serrano, J. M. (2015). Analysis of anaesthesia with ketamine combined with different sedatives in rats. *Veterinární Medicína*, 60(7), 368-375.

Neal, C. A., Nelson-Brantley, J. G., Detamore, M. S., Staecker, H., & Mellott, A. J. (2018). A Protocol for Decellularizing Mouse Cochleae for Inner Ear Tissue Engineering. *Journal of Visualized Experiments*, (131), e56523.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026366

Neuzil, J., Thomas, S. R., & Stocker, R. (1997). Requirement for, and promotion of, protein oxidation by, and inhibition of protein oxidation by, alpha-tocopherol. *Free Radical Biology and Medicine*, 23(1), 57-71.

Nevin, K. G., & Rajamohan, T. (2004). Beneficial effects of virgin coconut oil on lipid parameters and in vitro LDL oxidation. *Clinical Biochemistry*, 37(9), 830–835.

Nevin, K. G., & Rajamohan, T. (2006). Virgin coconut oil supplemented diet increases the antioxidant status in rats. *Food Chemistry*, 99(2), 260–266.

Rahim, N. S., Lim, S. M., Mani, V., Abdul Majeed, A. B., & Ramasamy, K. (2017). Enhanced memory in Wistar rats by virgin coconut oil is associated with increased antioxidative, cholinergic activities and reduced oxidative stress. *Pharmaceutical Biology*, 55(1), 825–832.

Rizk, H. G., Lee, J. A., Liu, Y. F., Endriukaitis, L., Isaac, J. L., & Bullington, W. M. (2020). Drug-Induced Ototoxicity: A Comprehensive Review and Reference Guide. *Pharmacotherapy*, 40(12), 1265–1275.

Schacht, J., Talaska, A. E., & Rybak, L. P. (2012). Cisplatin and Aminoglycoside Antibiotics: Hearing Loss and Its Prevention. *The Anatomical Record*, 295(11), 1837–1850.

Selimoglu, E. (2007). Aminoglycoside-Induced Ototoxicity. *Current Pharmaceutical Design*, 13(1), 119–126.

Sha, S. H., & Schacht, J. (2000). Antioxidants attenuate gentamicin-induced free radical formation in vitro and ototoxicity in vivo: D-methionine is a potential protectant. *Hearing Research*, 142(1-2), 34–40.

Singh, U., Devaraj, S., & Jialal, I. (2005). *Vitamin E, Oxidative Stress, And Inflammation. Annual Review of Nutrition, 25(1), 151–174.* doi:10.1146/annurev.nutr.24.0120

Wei, X., Zhao, L., Liu, J., Dodel, R. C., Farlow, M. R., & Du, Y. (2005). Minocycline prevents gentamicin-induced ototoxicity by inhibiting p38 MAP kinase phosphorylation and caspase 3 activation. *Neuroscience*, 131(2), 513–521.

Yusuf, A., Alhassan, A. W., Saleh, M. I. A., Adamu, B. Y., Olaide, L., Jamila, Z., & Aisha, Y. (2016). Anticonvulsant effects of Virgin coconut-oil, sodium valproate and phenobarbital in Wistar rats. *Archives of Basic & Applied Medicine*, 4, 121-124.

Zekrumah, M., Begua, P., Razak, A., Wahab, J., Moffo, N., Ivane, A., & Zhang, D. (2023). Role of dietary polyphenols in non-communicable chronic disease prevention, and interactions in food system: an overview. *Nutrition*, 112, 112034.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026367

Correlation Between Stress and Job Commitment among Public University Non-Teaching Staff in Edo State, Nigeria

OSAGIE, Eguagie
osagie.eguagie@uniben.edu.ng
08032218757/08056166108
Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin, Benin City, Edo State, Nigeria

Abstract
This study focused on the relationship between stress and job commitment among non-teaching staff in universities in Edo State, Nigeria. The study adopted a correlational research design to determine the extent to which job stress, organizational stress, and interpersonal stress are related to job commitment among non-teaching staff. Three research questions, and three hypotheses guided the study. The population of the study comprised all non-teaching staff working in public universities in Edo State. A sample of 250 non-teaching staff was selected using a multistage sampling technique to ensure adequate representation across different administrative units and departments. The instrument used for data collection was a structured questionnaire titled Stress and Job Commitment Questionnaire (SJCQ) developed by the researcher. The questionnaire contained items designed to measure job stress, organizational stress, interpersonal stress, and job commitment using a 4-Likert-type scale. The instrument was validated by three experts in Educational Management and Measurement and Evaluation from the University of Benin. A pilot study was conducted using non-teaching staff from a university outside the sampled institutions to test the clarity and suitability of the instrument. The reliability of the instrument was determined using Cronbach's Alpha method, which indicated satisfactory internal consistency. Data collection was carried out with the assistance of trained research assistants who distributed and retrieved the questionnaires from the respondents in their various offices. Mean and standard deviation were used to answer the research questions, while regression analysis was used to test the hypotheses at the 0.05 level of significance using the Statistical Package for Social Sciences (SPSS). The findings revealed significant relationships between job stress, organizational stress, interpersonal stress, and job commitment among non-teaching staff. The study concluded that workplace stress influences the level of commitment among non-teaching staff in universities. It was recommended that university management should implement effective stress management strategies and supportive workplace policies to enhance staff commitment and productivity.

Keywords: Job Stress, Organizational Stress, Job Commitment, Non-Teaching Staff.

Introduction
Universities make substantial contributions to national development by training skilled people, conducting research, and giving community service. In Nigeria, the effectiveness of the university system is decided not only by academic staff who are directly responsible for teaching and research, but also by non-teaching staff who provide administrative, technical, and support services that are required for the institution's smooth functioning. Non-teaching workers perform essential tasks such as record keeping, financial administration, technical services, library management, security operations, and maintenance. Through these tasks, they contribute significantly to the effective implementation of university policies and the achievement of institutional goals. As a result, the production and efficacy of universities are strongly dependent on the efficiency and dedication of both academic and non-academic employees. Several workplace factors, including the organisational environment, interpersonal relationships, and stress, have been identified as key predictors of employees' work attitudes and performance in the educational institutions. Job commitment is one of the most important organisational characteristics that are influenced by workplace environment. Job commitment is the degree to which employees identify with their organization, feel emotionally

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026367

attached to it, and are willing to put in effort to achieve its goals. It represents the psychological tie between employees and their employer. Ngozi, Emmanuel, Ashibene, and Ada (2025) define job commitment among non-teaching staff as the extent to which administrative and support personnel feel emotionally and psychologically connected to their institution and are dedicated to carrying out their responsibilities effectively. Employees that are highly committed to their jobs are more likely to be loyal, productive, and willing to contribute to the organization's overall success. Job commitment is regarded as a significant aspect in shaping individuals' attitudes about work and organisational outcomes. According to Adu-Gyamfi and Adu-Oppong (2017), devoted employees are more likely to report higher levels of job satisfaction, lower absenteeism, and better workplace performance. In contrast, low levels of job commitment may result in poor job performance, apathy toward organisational goals, and higher staff turnover. The commitment non-teaching staff' is especially crucial in university settings since their services support administrative and operational processes that facilitate teaching, research, and institutional development.

In the university, stress can occur in different forms depending on the nature of job demands and the work environment. Stress seems to have become a commonplace in the universities as employees deal with increased workloads, technology improvements, administrative pressures, and interpersonal challenges. Within the context of this study, stress is conceptualized in three major dimensions: job stress**,** organizational stress, and interpersonal stress. Job stress refers to stress arising directly from the tasks and responsibilities associated with a particular job role. It may result from factors such as excessive workload, time pressure, role ambiguity, role conflict, and inadequate resources required to perform assigned duties. Ehichoya (2025) explained that job stress occurs when employees experience high job demands combined with limited control over their work environment and insufficient resources to meet organizational expectations. When job stress becomes excessive, it may lead to fatigue, reduced job satisfaction, and diminished job commitment among employees. Job stress occurs when employees perceive a mismatch between job objectives and their ability or resources to achieve those demands. Occupational stress has been identified as one of the most critical factors influencing employees' psychological well-being, productivity, and dedication in organisations. According to Chinenye, Chukwuemeka, and Amobi (2017), occupational stress is a severe workplace issue that affects employee efficiency and effectiveness, particularly among non-teaching personnel at universities. When employees are exposed to extreme stress for an extended period of time, they may experience emotional tiredness, low morale, and a decline in job dedication. When employees are subjected to excessive stress for an extended period of time, it can result in emotional exhaustion, low morale, and a decrease in job commitment. Similarly, research has shown that occupational stress can have a significant impact on employees' perceptions of their company and motivation to accomplish their duties well (Madu et al., 2024). It appears that workers in higher education institutions frequently experience stress. For instance, Okorie and Oghuvbu (2023) discovered that most non-teaching staff members at universities in Edo and Delta States deal with moderate levels of stress at work. According to the report, 84.2% of non-teaching staff experienced moderate levels of occupational stress. This implies that university employees frequently experience workplace stress, which may have an impact on how committed and dedicated they are to their work. Post-secondary institutions, administrative and support staff frequently deal with stressful situations because of their severe workloads, bureaucratic processes, and restricted participation in institutional decision-making processes (Majekodunmi, 2022). Excessive job stress can lower an employee's motivation and undermine their bond with the company. Additionally, research has shown that stress at work might affect workers' commitment to company objectives,

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026367

job happiness, and productivity. Another important dimension of stress is organizational stress, which refers to stress arising from organizational structures, leadership practices, policies, and administrative procedures. Organizational stress may occur when employees perceive poor communication, lack of managerial support, inadequate recognition, or limited participation in decision-making processes. Majekodunmi (2022) noted that organizational practices such as ineffective human resource management policies and limited involvement of employees in policy formulation can create stressful working conditions that influence employees' attitudes and satisfaction levels. In university environments where bureaucratic procedures and administrative pressures are common, organizational stress may significantly influence the commitment of non-teaching staff. Another dimension of stress that could affect job commitment is interpersonal stress. Interpersonal stress arises from social interactions and relationships within the workplace. Interpersonal stress occurs when employees experience conflicts, poor communication, or strained relationships with colleagues, supervisors, or subordinates. Healthy interpersonal relationships are essential for teamwork, cooperation, and effective organizational functioning. However, when employees encounter conflicts or lack support from colleagues and supervisors, it may lead to psychological strain and reduced motivation at work. Oludeyi (2015) emphasized that workplace relationships and collegial interactions play a significant role in shaping employees' attitudes and commitment to their organization. Poor interpersonal relationships within the workplace may therefore create stressful working conditions that reduce employees' willingness to remain dedicated to their job responsibilities.

Empirical studies have consistently demonstrated that workplace stress can significantly influence employees' work attitudes, performance, and commitment. For example, Madu et al. (2024) found that workplace stress has a significant relationship with employee productivity and organizational commitment among non-teaching staff in Nigerian universities. Similarly, research by Adu-Gyamfi and Adu-Oppong (2017) revealed that employees who experience poor working conditions and job-related stress are more likely to demonstrate lower levels of organizational commitment and reduced work performance. Other studies have also shown that organizational factors such as leadership style, emotional intelligence, and workplace relationships can influence employees' job commitment and stress management capabilities (Akintayo & Dahir, 2024). Likewise, research conducted among non-teaching staff in universities in Kenya and the Philippines has shown that organizational conditions and stress levels play an important role in determining employees' commitment to their institutions (Kivindu, 2022; Payod & Canque, 2021). Despite the growing body of literature on workplace stress and employee commitment, limited empirical studies have specifically examined the relationship between stress and job commitment among non-teaching staff in universities in Edo State, Nigeria. Universities in the state continue to face administrative and organizational challenges that may contribute to stressful working conditions for employees. Understanding how different forms of stress—such as job stress, organizational stress, and interpersonal stress—affect the commitment of non-teaching staff is therefore essential for improving employee well-being and enhancing institutional effectiveness. Consequently, this study seeks to examine the relationship between stress and job commitment of non-teaching staff in universities in Edo State, Nigeria.

Objectives of the Study

The main objective of this study was to examine the relationship between stress and job commitment of non-teaching staff in universities in Edo State, Nigeria. Specifically, the study sought to:

1. Determine the relationship between job stress and job commitment of non-teaching staff in universities in Edo State, Nigeria.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026367

2. Examine the relationship between organizational stress and job commitment of non-teaching staff in universities in Edo State, Nigeria.
3. Investigate the relationship between interpersonal stress and job commitment of non-teaching staff in universities in Edo State, Nigeria.

Research Questions

1. What is the relationship between job stress and job commitment of non-teaching staff in universities in Edo State, Nigeria?
2. What is the relationship between organizational stress and job commitment of non-teaching staff in universities in Edo State, Nigeria?
3. What is the relationship between interpersonal stress and job commitment of non-teaching staff in universities in Edo State, Nigeria?

Hypotheses

H_{0_1}: There is no significant relationship between job stress and job commitment of non-teaching staff in universities in Edo State, Nigeria.

H_{0_2}: There is no significant relationship between organizational stress and job commitment of non-teaching staff in universities in Edo State, Nigeria.

H_{0_3}: There is no significant relationship between interpersonal stress and job commitment of non-teaching staff in universities in Edo State, Nigeria.

Methodology

This study adopted a correlational research design to examine the relationship between stress and job commitment of non-teaching staff in universities in Edo State, Nigeria. The design was considered appropriate because it enabled the researcher to determine the extent to which the independent variables (job stress, organizational stress, and interpersonal stress) are related to the dependent variable (job commitment) without manipulating any of the variables. The population of the study comprised all non-teaching staff working in public universities in Edo State, Nigeria. A total of 250 non-teaching staff participated in the study. The sample was selected using a multistage sampling technique. First, public universities in Edo State were identified, after which departments within the universities were stratified based on administrative units. From these units, non-teaching staff were randomly selected to participate in the study to ensure adequate representation across various departments and administrative cadres. The primary instrument used for data collection was a structured questionnaire titled *Stress and Job Commitment Questionnaire (SJCQ)* developed by the researcher. The instrument consisted of items designed to measure three dimensions of stress—job stress, organizational stress, and interpersonal stress—as well as job commitment among non-teaching staff. The questionnaire was structured on a 4-Likert-type scale with response options ranging from Strongly Agree to Strongly Disagree. The instrument was designed to capture respondents' perceptions and experiences regarding workplace stress and their level of commitment to their job roles and institutions. To ensure the validity of the instrument, it was subjected to face and content validation by three experts: two specialists in Educational Management and one expert in Measurement and Evaluation from the University of Benin. Their suggestions led to the modification of ambiguous items and ensured that the questionnaire items were properly aligned with the objectives and research questions of the study. A pilot study was conducted using non-teaching staff from a university outside the sampled institutions to test the clarity and suitability of the instrument. The reliability of the instrument was determined using Cronbach's Alpha method, which yielded a satisfactory reliability coefficient, indicating that the instrument possessed acceptable internal consistency for the study.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026367

Data collection was carried out with the assistance of trained research assistants who helped distribute and retrieve the questionnaires from the respondents within their various offices. Ethical approval was obtained from the relevant university authorities, and permission was granted by the administrative heads of the selected institutions. Respondents were informed about the purpose of the study and were assured of confidentiality and anonymity. Participation in the study was voluntary, and no personal identifiers were required from the respondents. Data collected were analyzed using descriptive and inferential statistics. Mean and standard deviation were used to answer the research questions, while regression analysis was employed to test the hypotheses. The regression analysis was used to determine the predictive relationship between job stress, organizational stress, interpersonal stress, and job commitment among non-teaching staff. All hypotheses were tested at the 0.05 level of significance using the Statistical Package for Social Sciences (SPSS). Through this methodological framework, the study examined how different dimensions of stress relate to the level of job commitment among non-teaching staff in universities in Edo State, Nigeria.

Presentation of Results

Hypothesis One:

There is no significant relationship between job stress and job commitment of non-teaching staff in universities in Edo State, Nigeria.

Regression Analysis of the Relationship between Job Stress and Job Commitment

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	15240.516	1	15240.516	412.873	.000b
Residual	9155.284	248	36.916		
Total	24395.800	249			

Coefficients Table

Model	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t	Sig.
(Constant)	12.384	1.842		6.721	.000
Job Stress	-0.845	0.042	-0.789	-20.327	.000

Dependent Variable: Job Commitment, **Predictors:** (Constant), Job Stress

The result shows that job stress significantly predicts job commitment among non-teaching staff in universities in Edo State. Job stress accounted for 62% of the variance in job commitment ($R^2 = 0.62$, $F(1, 248) = 412.87$, $p < 0.05$). The standardized coefficient (Beta = -0.79) indicates a strong negative relationship. This implies that as job stress increases, job commitment decreases. Since the p-value (.000) is less than 0.05, the null hypothesis is rejected. Therefore, there is a significant relationship between job stress and job commitment.

Hypothesis Two:

There is no significant relationship between organizational stress and job commitment of non-teaching staff in universities in Edo State, Nigeria.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026367

Regression Analysis of the Relationship between Organizational Stress and Job Commitment

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	12875.940	1	12875.940	298.456	.000b
Residual	11519.860	248	46.451		
Total	24395.800	249			

Coefficients Table

Model	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t	Sig.
(Constant)	10.927	2.103		5.197	.000
Organizational Stress	-0.692	0.040	-0.729	-17.276	.000

Dependent Variable: Job Commitment; **Predictors:** (Constant), Organizational Stress

The analysis indicates that organizational stress significantly predicts job commitment among non-teaching staff. Organizational stress explained 53% of the variance in job commitment ($R^2 = 0.53$, $F(1, 248) = 298.46$, $p < 0.05$). The standardized coefficient (Beta = -0.73) reveals a strong negative relationship. This means that higher levels of organizational stress lead to lower job commitment. Since the significance value (.000) is less than 0.05, the null hypothesis is rejected. Thus, there is a significant relationship between organizational stress and job commitment.

Hypothesis Three:

There is no significant relationship between interpersonal stress and job commitment of non-teaching staff in universities in Edo State, Nigeria.

Regression Analysis of the Relationship between Interpersonal Stress and Job Commitment

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	9642.370	1	9642.370	189.514	.000b
Residual	14753.430	248	59.484		
Total	24395.800	249			

Coefficients Table

Model	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t	Sig.
(Constant)	14.215	2.214		6.420	.000
Interpersonal Stress	-0.581	0.042	-0.633	13.766	.000

Dependent Variable: Job Commitment; **Predictors:** (Constant), Interpersonal Stress

The findings reveal that interpersonal stress significantly predicts job commitment among non-teaching staff. Interpersonal stress accounted for 40% of the variance in job commitment ($R^2 = 0.40$, $F(1, 248) = 189.51$, $p < 0.05$). The standardized coefficient (Beta = -0.63) indicates a moderate negative relationship. This suggests that as interpersonal stress increases, job commitment decreases. Since the p-value (.000) is less than 0.05, the null hypothesis is rejected. Therefore, there is a significant relationship between interpersonal stress and job commitment among non-teaching staff in universities in Edo State, Nigeria.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026367

Discussion of Findings

The findings of this study revealed a significant relationship between job stress and job commitment among non-teaching staff in universities in Edo State, Nigeria. The regression result showed that job stress significantly predicted job commitment. The result indicated a strong negative relationship, suggesting that as job stress increases, the level of job commitment among non-teaching staff decreases. This implies that excessive workload, time pressure, and other work-related stressors may reduce employees' psychological attachment, dedication, and willingness to remain committed to their institutions. This finding is consistent with the study conducted by Chinenye et al. (2017), who examined occupational stress and the performance of non-teaching staff in selected universities in South-Eastern Nigeria. Their findings revealed that occupational stress has adverse effects on employees' work outcomes and reduces their effectiveness and commitment to assigned duties. The authors emphasized that persistent stress conditions weaken employees' morale and reduce their willingness to contribute optimally to institutional goals. Similarly, Madu et al. (2024) reported that workplace stress significantly influences employee productivity and commitment among non-teaching staff in tertiary institutions. Their study indicated that high levels of job stress create dissatisfaction and emotional exhaustion, which ultimately lead to reduced commitment and lower levels of organizational involvement among staff. The result of this study also aligns with the findings of Ehichoya (2025) which revealed that job stress has a strong influence on employees' work attitudes and behavioural outcomes, including commitment and productivity. This suggests that when staff experience high stress levels, their dedication to work and willingness to remain loyal to their organizations decline significantly. The results also revealed a significant relationship between organizational stress and job commitment among non-teaching staff in universities in Edo State. The findings indicate that institutional conditions such as poor management practices, inadequate resources, bureaucratic procedures, and lack of participation in decision-making significantly influence employees' commitment levels. The result suggests that an increase in organizational stress leads to a corresponding decrease in job commitment among staff. This finding agrees with the study conducted by Oludeyi (2015), who found that organizational factors such as leadership style, communication structure, and workplace policies significantly influence the commitment level of non-teaching staff. According to the author, unfavourable organizational environments create stress that weakens employees' emotional attachment and loyalty to the institution. Similarly, Kivindu (2022) reported that organizational conditions play a crucial role in determining employees' commitment. The study concluded that when employees perceive their work environment as stressful or unsupportive, their level of commitment and sense of belonging to the organization decline. In addition, Ngozi et al. (2025) found that institutional leadership practices significantly predict job commitment among non-teaching staff. Their study showed that supportive leadership and ethical management reduce organizational stress and improve employees' commitment to their duties. The findings further revealed a significant relationship between interpersonal stress and job commitment among non-teaching staff in universities in Edo State. The results indicate that workplace relationships, including interactions with colleagues and supervisors, play an important role in determining employees' commitment levels. The findings suggest that as interpersonal conflicts and strained workplace relationships increase, employees' commitment to their jobs decreases. This finding is in agreement with the study conducted by Adu-Gyamfi and Adu-Oppong (2017), who indicated that poor interpersonal relationships and lack of cooperation among staff contribute

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026367

significantly to low commitment levels. The study noted that interpersonal tensions within the workplace often lead to dissatisfaction, absenteeism, and reduced commitment among employees. Similarly, Akintayo and Dahir (2024) revealed that effective interpersonal relationships and emotionally intelligent leadership significantly enhance employees' commitment to their work. Conversely, poor interpersonal interactions and lack of emotional support within the workplace contribute to increased stress and lower commitment levels among staff. The findings are also supported by Faloye, Daramola, and Owoeye, who observed that organizational support and positive workplace relationships significantly influence employees' performance and commitment in tertiary institutions. Their study emphasized that employees who experience supportive relationships with colleagues and supervisors are more likely to remain committed to their work responsibilities.

Conclusion

This study examined the relationship between occupational stress and employee performance among university staff. The findings indicate that occupational stress is an important factor that can influence the effectiveness and productivity of employees within tertiary institutions. Evidence from the study suggests that when job demands become excessive and are not properly managed, they can negatively affect workers' efficiency, commitment, and overall job performance. The results align with previous studies which indicate that occupational stress is a major challenge in organizational settings, particularly in academic institutions where employees are required to balance teaching, administrative, and research responsibilities. The study therefore concludes that occupational stress plays a significant role in determining the performance of employees in tertiary institutions. If stress is not properly managed, it may reduce job effectiveness, increase fatigue, and affect employees' commitment to their duties. Conversely, when institutions implement appropriate stress management strategies and supportive work environments, employees are more likely to demonstrate higher levels of performance, motivation, and organizational commitment.

Recommendations

Based on the findings of the study, the following recommendations are made:

1. University management should introduce stress management programmes such as workshops, counselling services, and training sessions that help employees develop effective coping strategies for work-related stress.
2. Academic institutions should ensure equitable distribution of duties among staff members in order to reduce excessive workload, which is one of the major causes of occupational stress.
3. Management should create a supportive work environment by providing adequate facilities, instructional resources, and administrative support that can help staff perform their duties more efficiently.
4. Institutions should adopt policies that encourage work–life balance, such as flexible schedules and reasonable deadlines, to help employees maintain both personal well-being and professional productivity.
5. University authorities should periodically assess the stress levels of employees through surveys or institutional reviews so that early interventions can be implemented when stress levels become excessive.

References

Adejumoke, D. A., Bankole, V. M. B., & Adeyemi, J. K. (2024). Relationship between work ethics and senior non-teaching staff's productivity in South-South universities in Nigeria. *Benin Journal of Educational Studies, 29*(1 and 2), 125–132.

Zamfara International Journal of Sci. Tech. Educ. & Mathematics
The Official Journal of the Department of Science Education
Federal University Gusau, Zamfara State, Nigeria
Volume 3, Number 1, March, 2026
ISSN: 2251 – 0974

www.foefugusau.com.ng
des@fugusau.edu.ng
DOI: https://doi.org/10.64348/zije.2026367

Adu-Gyamfi, M., & Adu-Oppong, A. A. (2017). Job satisfaction and commitment among non-teaching staff of universities in Ghana. *International Journal of Academic Research in Business and Social Sciences, 7*(6), 1–12.

Akintayo, S. O., & Dahir, A. H. (2024). Leadership styles and emotional intelligence as predictors of job commitment among non-teaching staff of the University of Ibadan. *International Journal of Humanities, Social Science and Management, 4*(2), 55–66.

Chinenye, O. C., Chukwuemeka, E., & Amobi, D. (2017). Occupational stress and the performance of non-teaching staff of selected universities in South Eastern Nigeria. *Management Studies and Economic Systems, 3*(3), 195–203.

Ehichoya, M. (2025). Job stress and employee performance among academic staff in University of Benin, Benin City, Edo State. *Journal of Organizational and Global Affairs, 9*(1), 44–58.

Kivindu, F. K. (2022). Perceived factors influencing organizational commitment among non-teaching staff in the University of Nairobi. *African Journal of Organizational Studies, 5*(1), 33–48.

Madu, M. B., Ibeme, N. P., & Abdulrasheed, A. A. (2024). Analysis of workplace stress levels on employee productivity among non-teaching staff at the National Open University of Nigeria. *UNIZIK Journal of Management and Social Sciences, 5*(1), 112–124.

Majekodunmi, A. S. (2022). *Strategic human resource management practices and job satisfaction of non-teaching staff in public universities in Lagos State* (Doctoral dissertation). ProQuest Dissertations Publishing.

Ngozi, N. A., Emmanuel, O. D., Ashibene, O. J., & Ada, O. G. (2025). Exploring the relationship between ethical leadership and job commitment of non-teaching staff in the University of Calabar, Cross River State, Nigeria. *International Multidisciplinary Journal of Research, 10*(2), 45–58.

Okorie, N. C., & Oghuvbu, E. P. (2023). A study on the level of stress among non-teaching staff of universities in Edo and Delta States. *Nigerian Journal of Educational Management*, 21(2), 88–101.

Oludeyi, O. S. (2015). Workplace factors as determinants of job commitment among senior non-teaching staff of Olabisi Onabanjo University, Nigeria. *Journal of Human Resource Management, 3*(4), 65–74.

Payod, E. P., & Canque, M. S. (2021). Organizational commitment of non-teaching personnel in a state university in the Philippines. *Turkish Journal of Computer and Mathematics Education, 12*(10), 3285–3293.